THE

# ELECTRICAL REVIEW.

VOL. XXXII. JUNE 2, 1893. No. 810

## CONTENTS:

| | PAGE |
|---|---|
| The Interdependence of Abstract Science and Engineering ... | 641 |
| £500,000 for Long-distance Telephony ... ... ... ... | 642 |
| Gas Engine Sub-stations ... ... ... ... ... | 643 |
| Facts and Figures on Electrolytic Chlorine and Soda ... ... | 644 |
| Energy as a Fundamental Idea ... ... ... ... ... | 646 |
| Amidon's Corner Brace (*illustrated*) ... ... ... ... | 647 |
| Long-distance Transmission of Power ... ... ... ... | 647 |
| Arc Lighting.—I. ... ... ... ... ... ... ... | 648 |
| Electricity in Metallurgical Operations: Laboratory Furnaces (*illustrated*) ... ... ... ... ... ... ... | 650 |
| Sayers's Improvements in Dynamos ... ... ... ... | 651 |
| Rotary Magnetic Fields (*illustrated*) ... ... ... ... | 652 |
| Practical Notes on the Steam Jacket (*illustrated*) ... ... | 653 |
| Joel's Electromotors.—The Day Load ... ... ... ... | 655 |
| Reviews ... ... ... ... ... ... ... ... | 655 |
| Paper Insulation (*illustrated*).—Obituary ... ... ... | 656 |
| New Engineering and Electrical Laboratories at University College, London ... ... ... ... ... ... | 657 |
| Notes ... ... ... ... ... ... ... ... ... | 657 |
| Contracts Open and Closed.—Business Notices, &c. ... ... | 661 |
| City Notes, &c.:—Elmore's American and Canadian Company | 662 |
| The Westinghouse Electric and Manufacturing Company ... | 663 |
| Reuter's Telegram Company.—Traffic Receipts ... ... | 663 |
| Share List of Electrical Companies ... ... ... ... | 664 |
| Proceedings of Societies:— | |
| The Institution of Electrical Engineers (*illustrated*) ... | 665 |
| New Patents ... ... ... ... ... ... ... ... | 667 |
| Abstracts of Published Specifications ... ... ... ... | 668 |
| Carbon Manufacture in England ... ... ... ... ... | 668 |
| Correspondence:—Paralleling of Alternators ... ... ... | 669 |
| Cooking and Heating by Electricity ... ... ... ... | 669 |
| Relative Safety or Danger of Electric Light Current ... | 671 |
| Figure of Merit of Galvanometers ... ... ... ... | 672 |
| Electrolytic Chlorine and Soda ... ... ... ... | 672 |
| Armature Heating.—Train Lighting ... ... ... ... | 672 |

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## THE INTER-DEPENDENCE OF ABSTRACT SCIENCE AND ENGINEERING.

THIS was the title of the first "James Forrest" Lecture, delivered on May 4th, at the Institution of Civil Engineers, by Dr. William Anderson, F.R.S. At the outset the lecturer explained that the subject seemed to have been prescribed because of an uneasy feeling which possesses thoughtful men, that this country is not keeping pace with its neighbours in engineering progress, and that in the future we shall have to pay more attention than formerly to abstract science and its practical application. Whether this feeling is justified by facts, we cannot tell, but inasmuch as the dread of such a degeneration has been the means of some splendid developments, including the lecturer's brilliant address, we are inclined to encourage the notion in others, if not entirely cherishing it ourselves.

Dr. Anderson justly denounces the one-sided direction which popular scientific education has sometimes taken, by restriction to mechanical and technical instruction alone; and he urges the necessity of teaching the great economic principles of trade and labour, as well as the mere technical knowledge of a particular art or craft. Unscrupulous politicians, and cheap newspapers, with their blind advocacy of popular fallacies, are held responsible for a great deal of mischief, by suggesting hopes of shortened hours of labour and a number of other things, to which employers stoutly object. Whether a course of lectures on political economy would have quelled the Hull strike, we cannot tell; it might have been tried with some advantage. It is not easy to teach men principles which are opposed to their objects, and for this reason technical and mechanical instruction will always be listened to in preference to abstract knowledge. Workmen will submit to being taught how to *work*, for it may mean money in their pockets; but they will not, consciously, submit to being taught how to *think*; they have their own way of forming conclusions.

It was well argued by Dr. Anderson that the onus of procuring grist for the mill falls in no way upon the wage-earning portion of the community, but rests entirely with the employers; and it is here that the professional skill, mercantile ability, and the forces of capital, are brought to the front. The risk of the enterprise is with the financiers, not with the workmen. The lecturer applied the doctrine of Carnot to the question of national prosperity, in illustration of the inter-dependency of classes and masses. To ensure active trade and prosperous manufactures there must be a fall of money from the wealthy to the poor; the prosperity of the community is bound up in the existence of these differences, and a dead level of wealth would be a dead level of poverty, which would end, as a state of uniform temperature must end, in inactivity. With this we entirely agree, as long as Dr. Anderson restricts himself to *bonâ fide* capitalists, as distinguished from sportive financiers. In the

human engine of Carnot there is a principle of "reversibility" which here asserts itself. Everything depends upon the man that stokes.

From financier to engineer is, at the present day, such a little step, that the lecturer seems scarcely conscious that he takes it; he leads us from one to the other in natural sequence; so that while at one moment he is discoursing upon the virtues of the capitalist, he is at the next telling the achievements of James Watt and the men who built England. At first sight it is a little difficult to trace why this transition should be so easy. Is it that engineers are becoming capitalists? or can it be that capitalists prefer to be classed as engineers? It will be remembered that when the elfin knight, Guyon, discovered Mammon "in a delve, sunning his treasure hore," he found him disguised as an engineer of the period, his face tanned with smoke, and his hands sear'd with coal dust. It would be indeed strange if financial gentlemen of the present day should adopt the same devices as those of which Spencer wrote so long ago.

Having established the inter-dependence of the various grades of the body politic, the operative and the capitalist, Dr. Anderson develops his subject, and shows the relations which subsist between abstract ideas and actualities. In a most interesting manner he describes the labours of such men as Smeaton, showing how valuable were his theoretical investigations upon steam, with regard to the practical construction of the steam engine. The girder bridge is given as a further example of the aid which abstract science can render to efficient design; while thermo-chemistry has been of similar service in showing the limits of economy which can be reached in the manufacture of iron. The determination of the mechanical equivalent of heat has also been of practical importance, and is applicable even to the conversion of heat into the work done in the bore of a gun. And lastly, as the loftiest abstract conception relating to the structure of the universe, Dr. Anderson instanced the luminiferous ether, which is now as familiar to us as if it could be seen or weighed, and is indeed, according to Lord Kelvin, the only substance of which we are confident in dynamics. The application of these recondite ideas is only beginning. Spectrum analysis was one of its first manifestations, and the recent developments in electricity are to be regarded as an indication of what may be expected.

## £500,000 FOR LONG-DISTANCE TELEPHONY.

PROF. SILVANUS THOMPSON predicts that we are within reach of some great world-compelling idea, which shall give a directive impulse to the wings of thought, and a new power to the wheels of trade. Electricians, ever on the tip-toe of expectation towards discovery, are looking around them to find where the innovation is to come, and the notion of long-distance telephony seems a likely second, if not the absolute first in the field. Whatever it is when it does appear, of this we may be certain: someone will have invented it before; and as several people have already had a turn at the telephone cable, it is as likely to be the wished-for compeller as anything we know. The electro-static, *cum* magnetic, *sans* wires system was a Tesla dream a year ago; and the more recent *sans* wire system, lately laid, was probably a dream of Faraday 60 years since. We are led to believe in the impossible, the romantic, the all-but-absurd; for we find the impossible does happen, the romantic may happen, and the all-but-absurd might happen; in the attempt to attain these things inventors stumble across such oddities as microphones, telephones, and phonographs.

"The official representative of Great Britain in matters electrical" has, in his time, said some very curious things about telephone cables in England and America, to more or less purpose. As the result of what he has said and done, together with what others have done and said, we can now talk to Paris. Twelve months' hence we hope to have the felicity of speaking to Holland; and there is a terrible danger that we may be able to listen to Dutch at about the same time. Dr. Thompson was right in saying that "long-distance telephony is no mere dream." Indeed, Dutch by telephone is a horrible nightmare.

A preliminary canter across the English Channel is very well in its way, but an Atlantic submarine cable is a very different project. None but those who have been practically engaged in long-distance cablery can appreciate the difficulties and dangers, the stresses and strains that such work implies. In looking for a new type of cable to be used for Atlantic distances in telephony, every telegraph engineer will see the necessity of working well within the present rules for its design, as regards strength and durability; but the system involves other factors of which we are as yet almost ignorant; conditions are necessary which can be arrived at only by a well organised series of attempts. Help can only be derived from experiment.

We are not clear as to what Mr. A. Siemens intended to imply in his discussion upon Prof. Thompson's paper, at the Society of Arts, by hinting at the suppression of the results of experimental researches in the matter of telephone cables. The truth is that the Treasury have made a grant of £500,000 to develop long-distance telephony. With this sum Mr. Preece hopes, "with the help of Mr. Siemens," to "lay a speaking cable across the Atlantic." Mr. Siemens confesses that experiments with such cables are extremely costly, and involve a great deal of time, trouble, and knowledge; and he adds, suggestively, that it is "not likely that results attained with such difficulty would be published in a hurry, without a very strong inducement." It is our purpose now to offer that very strong inducement to Mr. Siemens to publish these results as soon as possible; and we cannot do better than urge as our reason that which was given by Prof. Thompson in reply. "Surely, if such experiments are so costly, that is the very reason why, *when they are made at the public expense*, the results should be published. It is just these facts which scientific men want to get hold of." All at the proper place and time, of course, but we contend that these results must not be monopolised by the few fortunate individuals into whose hands the public means have fallen; and we think Mr. Siemens was ill-advised even to suggest that they should be withheld from other theorists and cable contractors. We trust that "the official representative of Great Britain, in matters electrical," will see to it, that Mr. Siemens shall want no further inducement in this regard.

## GAS ENGINE SUB-STATIONS.

WE have more than once referred to the likelihood of gas engine sub-stations taking the place of electrical converter sub-stations where circumstances are favourable. The two essentials required are, that coal should be abundant, and therefore cheap, and that the lighting should cover an area having compact districts, each of which could be supplied from a sub-generating station. The patchy character of such lighting is one which exists in several of our North country towns. In these, too, the gas monopoly is largely in the hands of the local authorities, which is an important point to consider when a municipal electricity supply is projected. The generating station would then be the gas works, and the high pressure feeders of a converted supply system would give place to gas mains. The Dowson gas plant would, in all probability, be that adopted, if existing works were not under municipal control; and, judging from the examples of this system which are at work, every confidence could be felt in the adoption of such a scheme. The Popp system in Paris would have possessed a much more valuable concession if gas had been taken as the medium for first distribution instead of compressed air. An additional argument in favour of gas engines used in this way has been afforded by the publication of figures as to the cost of lighting a large building by electricity from a private plant. It was there found, by exact experiment extending over two years, that with gas at 2s. 9d. per 1,000 cubic feet, the cost of gas worked out at 1·1 pence per unit generated, the total cost coming to 3d. per unit, including attendance, interest and depreciation of plant, &c. The resultant economy showed a saving of 12½ per cent. per annum in favour of electricity. It is rather a coincidence that Prof. Kennedy's estimate of the engine room cost per unit generated by the Westminster Company for this year should be the same figure, viz., 1·1 pence. We have recently devoted some attention to Liverpool electric lighting, and there the local circumstances have caused the company to go in for four generating stations rather than sub-station converters on a high tension system. The special knowledge of the managing engineer must have been the cause of their taking this course, and they express themselves as convinced of its wisdom. Here, again, is an argument in favour of gas engine sub-stations, for if economy is in favour of several stations rather than a single one of greater size, it seems not unlikely that when greater attention is paid to the gas engine in large sizes, and suitable means are taken to draw attention to the fact that such are to be obtained, some of the numerous supply concerns will find it to their interest to look very closely into the question, and to end by making a practical trial on a sufficiently large scale to prove that electricity can be so generated efficiently and commercially.

Mr. McMullen, who himself is advising a local authority, recently stated that one of the principal objections to gas engines was the varying crank effort. He assumes because a gas engine has a velocity which is susceptible of considerable variation throughout a complete stroke, therefore it must be unsuited to drive alternators. Were it necessary to run alternating machines parallel to obtain commercial success it would be another matter, but the engineer of one of our most successful stations has definitely and distinctly stated that from economic and financial considerations such a method of running is not essential. It may be, in some respects, advantageous and helpful, but need not stand in the way of alternator systems using gas engines as prime movers. If parallel running were so necessary the Metropolitan Company, with their Willans alternator direct-coupled sets would be badly off, but the consensus of opinion is gradually, but surely, tending to a calmer and more impartial review of the *pros* and *cons* of what was once a burning question.

**The Transformation of Electrical into Chemical Energy.**

REGNAULT observed some time ago, that liquid gallium is electropositive to solid gallium in a neutral solution of gallium sulphate (*vide Chemical News*, Vol. xxxviii, p. 33.) This interesting observation received something like confirmation from Gore (*vide Philosophical Magazine*, series 5, Vol. xxxii, page 27), who made corresponding observations with various alloys. Gore's paper, which occupied about five pages, may be illustrated by the following brief account. A glass dish and a tobacco pipe with a wide bowl were partially filled with a conducting liquid (a solution of hydrochloric acid or of sodium chloride), and connected by means of a siphon. A rod of some solid alloy was placed in the cup and a second portion was melted in the bowl of the pipe. Connection was made through a galvanometer by means of iron wires. The alloy in the bowl was alternately heated and cooled, the galvanometer being observed in order to ascertain if there was any deflection of unusual magnitude when the temperature passed the melting point of the alloy. As most of the alloys employed in this research did not melt sharply, no very sudden deflection was noted, but in the case of an amalgam of one part of cadmium with four parts of mercury in a solution of sodium chloride, there was a sudden reversal of the current when the amalgam completely liquefied, the liquid being electronegative to the solid at this point. Both Gore and Regnault have maintained that the change in the electromotive force of a galvanic element when the metal or alloy forming one of the electrodes, passes its fusing point is a sudden one. This view has been put forward without contradiction by several other physicists, but in a paper by L. Miller, published in the *Zeitschrift für physikalische chemie*, (Vol. x, p. 459), the author points out that this view is theoretically impossible because it leads to a contradiction of the second law of thermodynamics. Not content with entering into a theoretical discussion of the value of this question, Miller has approached it from the experimental side. The following is a brief account of his operations. A galvanic element consisting of two metals immersed in a suitable electrolyte, was placed in a large test tube. One of the metals was of such a nature that it could be fused below the highest temperature of the experiment. The more fusible metal was melted into one limb of a U-tube: this limb being short and wide, whilst the other was long, and capillary contact was made by means of a platinum wire passing down the capillary tube. The bulb of the thermometer was dipped into the fused metal which was then allowed to solidify around it. The potential difference between the two metals was ascertained by means of a capillary electrometer, the error of experiment being about 0·001 volt. The temperature of the element was then gradually raised and the electromotive force read off at every degree in the neighbourhood of the melting point of the metal. As the result of experiments with combinations of lead and silver in fused potassium and zinc chloride, mercury and cadmium amalgam in 50 per cent. sulphuric acid, and tin and silver in a fused mixture of the nitrates of potassium, sodium and cadmium, Miller finds that no sudden jump in the value of the electromotive force takes place at the melting points of lead, mercury and tin. He submits that it is difficult to make accurate observations with alloys, on account of the chemical changes which takes place on their surface.

## FACTS AND FIGURES ON ELECTROLYTIC CHLORINE AND SODA.

BY EMILE ANDREOLI.

(*Concluded from page* 558.)

I HAVE been the first to welcome the good news of the commercial production by electrolysis of chlorine and caustic soda at Snodland being an accomplished fact, and I am, most certainly, far from disparaging the Richardson and Holland process, but, the more I read the reports of the experts published in the *Paper Makers' Circular and Rag Merchants' Gazette and Price Current*, the more I find it was not fair play to represent the results of the experiments at Snodland as being unequalled and insuperable. There are five or six electro-chemists in this country and in the United States, who can, more or less, say of what the Snodland people do. We all do it, and even we do it better and cheaper. It is not indispensable for an electro-chemist to have decomposed 363 lbs. of common salt per week during a few months in 13 tanks, through which a current of 500 amperes and 80 volts are passing, to be entitled to claim that he also can manufacture bleach and caustic by electrolysis.

The whole affair lies in a nutshell, as the object is to yield a maximum of bleach and caustic with the expenditure of a minimum of electrical energy. To this may be added that if the anodes are good, strong, and made of a material which is not attacked, or is not readily destroyed by the gaseous or liquid products of the electrolysis, and are capable of standing long wear and tear, and if the separation of the ions is complete, no manufacturers, experienced chemist, or electro-chemist, will require to see the same electrolytic operation repeated during weeks and weeks before declaring the process to be good and practical. *Quod hodie verum est, cras verum erit et sic semper.* Once the electrolytic decomposition of chloride of sodium has taken place under certain conditions of cheapness, efficiency, and regularity, we must admit that this operation will be effected in the long run in the same manner, without any material change and with the same economical results; and I assume that, if after such a long period of experimental working at Snodland, the potential difference at the terminals of each tank is still 6 volts, we can little expect that it will be reduced to 4½ volts.

Electrolytic works ought to be established in districts where coal and salt are cheap. This is a condition, *sine quâ non*, of the possibility of the competition of electrolysis with the chemical production of chlorine and caustic soda. But there are 4,514 paper mills in the world—Germany, 1,443; United States, 859; United Kingdom, 342; France, 473; Italy, 234; Spain, 154; Russia, 43. In all these different countries the price of the commodities essential for electrolytic purposes varies, and it is delusory to speak of 2 lbs. of coal per H.P., of salt at 10s., and of coal at 8s. or 10s. per ton.

For instance, I have just received from the manager of an important mill on the Continent a letter in which he says: "Impure salt costs 25 francs per ton; coal 25 francs per ton; we consume 1,500 k. (3·6 lbs.) of coal per H.P. hour."

When eminent experts report on a process, they ought to stipulate that their report will not be published in any commercial paper or prospectus, before it has been first published and discussed in the scientific press, and that it ought to be published *in extenso* instead of extracts, as has been the case with the reports of Messrs. Preece and Gore on the Greenwood process. Who knows? They may be mistaken, they may represent as new and good what is neither a novelty, nor an invention, nor anything like perfection. Thus, in the Richardson and Holland present case, in spite of what I have written and the ELECTRICAL REVIEW has published on their anodes, their impervious diaphragm, &c., the paper merchants and rag merchants who have received and read *The Paper Makers' Circular and Rag Merchants' Price Current* will continue to believe that the best, the only electrolytic paying process for making bleach and caustic soda, is the one on which Messrs. Leith, Tate, Liveing, Massey, and Swinburne, have so favourably reported. What does it matter to the electrical thaumaturgists, whether the ELECTRICAL REVIEW and the electrical press have condemned or not certain galvanic belts. The public who read the testimonials and reports advertised in the daily papers has no knowledge or idea of the revelations made about the electric belt mongers, and not one out of 1,000 readers of the *Paper Makers' Circular and Rag Merchants' Price Current* knows, and will, perhaps, ever know, that the Richardson and Holland process is not quite the perfection it has been represented to be.

However good a process may be, it is not wise to exaggerate the profits which it may bring. Mr. Leith, one of the experts, makes the process give a balance of 46 per cent. above labour and material on a small scale at Snodland, where coal is at 11s. per ton, and salt and lime at 20s. per ton, with an old and obsolete type of engine. In an alkali district, where coal, salt, and lime are cheaper, and with an efficient generating plant, he estimates the balance at 265 per cent. above prime works cost. This is of course an enormous margin and shows that those who take up the manufacture of electrolytic soda at once may be able to make enormous profits before the price comes down. So much the better if the electrolytic process is so promising. 265 per cent. is a very nice balance, and all the electro-chemists who have devoted their time and researches to the solution of the problem will join with me and congratulate themselves for having worked at the applications of electrolysis, in preference to the other applications of electricity.

I will very reluctantly say a word on a question of patents. But how can I avoid doing so when one of the experts says that in the United Kingdom only, the production of bleaching powder and caustic soda amounts to £1,500,000 a year, and that "as the electrolytic company has, he is informed, patents in the United States, France, Austria, &c., their patents should be *even* more valuable in those countries." I have been looking through the American list of patents, and found that patents have been granted in the United States to Cutten, Kellner, Marx, Hoepfner, FitzGerald, Greenwood, Le Sueur, &c., but I have been unable to find one in the names of Richardson and Holland. In my opinion the anode and the impervious diaphragm must be a source of objections at the Washington Patent Office, and, I suppose, the Berlin *Patentamt* must find a great lack of novelty in the use of oxide of copper as a depolariser.

I see the experts do not speak of this use of oxide of copper, which was the object of two patents filed by Messrs. Richardson and Holland. Patents are like pamphlets: *habent sua fata libelli*; some may succeed, others are doomed. It would be too good if all patented inventions were really practical, economical and new. The use of oxides patented in 1889 by Messrs. Richardson and Holland had already been patented by an intimate friend of mine, who abandoned the process when he found that, in 1885, Hoepfner had claimed the use, as depolariser in electrolysis, of oxides which absorb hydrogen (amongst which, of course, was oxide of copper, the object of the claims of Messrs. Richardson and Holland). There was, therefore, no more originality and novelty in the employment of oxide of copper in an electrolytic tank than in their carbon anodes, or in their diaphragm.

I do not grudge the compliments paid by Messrs. Leith, Tate, Swinburne, &c., to the Snodland people, who have been in a position to prove, on a commercial scale, that electrolysis is cheaper than the Leblanc, or other chemical process. But a line must be drawn somewhere, and I refuse to allow anybody to proclaim that Richardson and Holland have alone solved the problem of commercial production of chlorine and caustic soda.

Possession is nine points of the law. Once in the place, the Snodland people would be the champions of electrolysis in the world, and unless some one protests now against the diploma of excellence and superiority granted to them by experts who affect to ignore that there are some other electricians who can compete with them, there would be no remedy, and it would be too late to complain of the usurpation.

As an invention, the Richardson and Holland process leaves me quite indifferent, as I do not see anything new in it.

As a process worked on a commercial scale, it does not strike me much, as it is in no way superior to what can be done. No doubt the Electrolytic Caustic Soda and Chlorine Trust, Limited, will be able to work it profitably as a private

concern, but what is there to prevent other people doing it in the same manner?

But returning to figures:—For each electrical horse-power, two tons of common salt *would* be decomposed per annum, with a potential difference, at the terminals of each vat, of 6 volts, and these two tons should yield 1·07 tons of Na 2 O, and in addition, 1·2 tons of chlorine gas, or its equivalent, $3\frac{1}{3}$ tons of chloride of lime, containing 37 per cent. of chlorine. The cost of electrical power to produce the above quantity of caustic and bleach, will be, therefore, according to Dr. Hopkinson, less than £8; to this must be added the cost of common salt, the cost of the tanks and of maintaining them, the cost of the electrodes, and the cost of concentrating the caustic soda, and packing it for the market; also the cost of absorbing the chlorine gas and packing the bleaching powder.

This is perfectly clear and precise, and there cannot be any mistake about these plain declarations; but what Dr. Hopkinson says applies to all electrolytic processes, and not to the Snodland process, which requires 6 volts per tank; and the end of his report does not leave even a shadow of doubt as to the inferiority of the Richardson and Holland method, which uses up more coal than any others. "Working on a large scale, the cost of electrical power will be less than £8; but *how much less* will *depend entirely upon the extent to which the figure of 6 volts*, which it has been demonstrated *is adequate* to effect the decomposition in practical working *can be* diminished."

Under such circumstances, the Snodland caustic and bleach do not appear to be produced as economically as by the other electrolytic methods, which can afford to obtain the same results with less motive power.

At first, my intention was to go into the figures of Dr. J. Hopkinson, and to elucidate this primordial question of the efficiency of the 6 volts system. But after deliberation, I have altered my mind, preferring to leave this problem on electrolytic calculations unsolved. What does Dr. J. Hopkinson mean, when in his report he speaks of the decomposition of salt? What is the efficiency of the Richardson and Holland process? Does it represent 80 per cent. as Greenwood's and Le Sueur's, or is it higher? What is the yield of chlorine and caustic soda? Is it 90, 93, or is it equal to 100 per 100, and is really the yield of chlorine at Snodland equal to the theoretical yield?

Another puzzle in the Hopkinson report is the following statement:—"To produce 3,000 electrical horse-power continuously the year through, if worked in a district where coal can be obtained at a low price, say, eight shillings per ton, will cost about £18,000 per annum for coal, wages, oil, stores, and repairs to machinery, which will keep it in as good a condition as new. Adding to this a liberal charge for writing off the engines and dynamos against a time at which they might, for the purpose of producing caustic soda, be superseded by some other method." It is extremely funny to find an expert anticipating in a report on a certain process for producing caustic soda, the probable eventuality of writing off the engines and dynamos, against a time *when they might for the purpose of producing* caustic soda (shall I say, and chlorine?) *be superseded by some other method.*

This report of Dr. Hopkinson does not tell us what the yield of chlorine and soda is in the vats of the Electrolytic Caustic and Soda Trust. We do not want to know how much *it should be*, as Dr. J. Hopkinson says, but how much this yield is. Theory is a fantastic horse which it is dangerous to ride. Is it not a known fact that the work of the horse-power corresponds to the decomposition of 167 grammes of water per hour, but that in practice, this decomposition does not represent more than 60 grammes of water per hour, setting free only 6·67 grammes or 74·4 litres of hydrogen and 53·33 grammes or 37·2 litres of oxygen.

There are more slips between practice and theory than between the cup and the lip. We desire to be told what the efficiency of the Richardson & Holland process really is, and we are, to a certain point, entitled to ask Dr. J. Hopkinson his opinion on this subject, not "from well established electro-chemical data," but from his experience. There is a discrepancy, which I should like to see explained, between his figures and the following estimated cost of producing caustic soda in drums and bleaching powder in casks by the Le Sueur electrolytic process, given at the Society of Chemical Industry, in December, 1892, by Messrs. Cross and Bevan.

*Cost of power.*

| | | | |
|---|---|---|---|
| Coal, 2,400 horse-power × 2½ lbs. × 24 = 64 tons at 10s. ... ... ... ... ... | £32 | 0 | 0 |

*Cost of production.*

| | | | |
|---|---|---|---|
| 18 tons of *salt at 12s. per ton* ... ... ... | £10 | 16 | 0 |
| 12 „ lime, 12s. per ton ... ... ... | 7 | 4 | 0 |

*Selling price of products (where these are caustic and bleach).*

| | | | |
|---|---|---|---|
| 22·43 tons of bleach, 37 per cent., at £7 10s. ... | £168 | 4 | 6 |
| 9·378 „ caustic soda at £12 ... ... ... | 112 | 10 | 0 |

*Soda ash and bleach.*

| | | | |
|---|---|---|---|
| 22·43 tons of bleach, 37 per cent., at £7 10s. ... | £168 | 4 | 6 |
| 12·46 „ ash at £5 15s. ... ... ... | 71 | 9 | 0 |

Please note the discrepancy between the figures given by Dr. Hopkinson and those given by Messrs. Cross and Bevan. Since 2 tons of salt give 1·2 tons of chlorine and 1·07 of soda, 18 tons of salt ought to give 10·8 tons of chlorine equivalent to 32·4 tons of bleaching powder. But Messrs. Cross and Bevan's estimate shows only 22·43 tons of bleach only.

Whose calculation is wrong?

Then, in the balance-sheet by Mr. Leith, "proving the very great value of the patents now being practically worked by the Electrolytic Company at Snodland," the eminent expert calculates that the following would be the cost of turning out, say 180 tons per week, *i.e.*, 52 tons of caustic soda, 76 per cent., and 128 tons of bleach 35 to 37 per cent. at St. Helen's by the Richardson and Holland process, and that the balance is upwards of £5 per ton.

| Dr. | £ | s. | d. |
|---|---|---|---|
| Wages:—10 stokers at 4s. 6d. ... ... ... ... | 15 | 15 | 0 |
| „ 4 men at 5s., 4 boys at 3s.—engines ... | 11 | 4 | 0 |
| „ 2 caustic finishers ... .. ... ... | 4 | 0 | 0 |
| „ 2 lime dressers ... ... ... ... | 3 | 0 | 0 |
| „ 4 bleach packers ... ... ... ... | 9 | 0 | 0 |
| „ 6 labourers ... ... ... ... ... | 6 | 0 | 0 |
| „ loco driver and brakesman ... ... | 4 | 0 | 0 |
| „ discharging and loading ... ... ... | 25 | 0 | 0 |
| Coal for boilers, 650 tons at 4s. 3d. ... ... ... | 138 | 2 | 6 |
| Coal for evaporating soda, 102 tons at 4s. 9d. ... | 24 | 4 | 6 |
| Salt, 100 tons at 6s. 6d. ... ... ... ... | 32 | 10 | 0 |
| Lime, 95 tons at 13s. ... ... ... ... ... | 61 | 15 | 0 |
| Drums and casks ... ... ... ... ... | 85 | 0 | 0 |
| Add 50 per cent. on cost of manufacture, office, management, rent, rates, taxes, repairs and contingencies ... ... ... ... ... ... | 200 | 15 | 0 |
| Balance ... ... ... ... ... ... ... | 902 | 13 | 0 |
| | £1,532 | 0 | 0 |

| Cr. | £ | s. | d. |
|---|---|---|---|
| 52 tons caustic, 76 per cent., at £11 ... ... ... | 572 | 0 | 0 |
| 128 tons bleach, 35 to 37 per cent., at £7 10s. ... | 960 | 0 | 0 |
| | £1,532 | 0 | 0 |

If, according to Dr. Hopkinson, 2 tons of salt give 1·2 tons of chlorine and 1·07 tons of Na 2 O, 100 tons of salt ought to give us 60 tons of chlorine which, multiplied by 3, would represent 180 tons of bleaching powder 36 per cent. Mr. Leith's balance-sheet shows only 128 tons of bleaching powder; there is, therefore, a difference of 52 tons, which, at £7 10s., represents a loss of £390 per week on every 100 tons of salt.

If reports by experts were to involve the same liability as statements made by directors in prospectuses, there would be more reliability in their calculations in prospectuses, and in these reports, often signed by illustrious names, there would be less promises of enormous profits. Electricity *v.* Gas, Electrical traction *v.* Animal traction, Electrolysis *v.* Chemistry *i.e.*, transformation of Chemistry in Electro-chemistry. This is not revolution, but evolution of progress. Nothing progresses like progress, and success must always be admired. In the present case, however, it has been a great wrong and injustice to proclaim the Richardson and Holland process as possessing advantages on the others which it does not really possess. No electrician who knows this question of electrolysis will admit that Messrs. Richardson and Holland deserve the repute of having solved the problem of the commercial electrolysis of salt. They have not succeeded in obtaining better results than the other electro-chemists; on the contrary, others can get more chlorine and caustic soda for each electrical H.P. than they can do.

No one will say that Richardson and Holland have discovered the production of chlorine and caustic soda.

They have not even invented a new kind of anode, and they have no more invented their impervious compartment extending from the lid downwards to within a short distance from the bottom than they have invented the use of oxides as depolarisers which prevents the reducing action of hydrogen.

When Planté constructed his small secondary battery, Gramme his dynamo, Edison and Swan their lamps, Faure, Sellon, Volkmar their accumulators, Gaulard his transformers, there was an invention in what these electricians created. What Richardson and Holland have been doing is simply endeavouring to improve what has been done before them, or what is done presently. As far as we can judge, the work of the Electrolytic Caustic Soda and Chlorine Trust is scarcely what may be called an improvement, and any other process applied under the same conditions would most certainly have given better results. Therefore, the Snodland people will have to work and improve a great deal their electrolytic production of chlorine and caustic soda before they can do better than the other electro-chemists who are ready to supply the papermakers and bleachers with the plant and machinery required for small or large electrolytic installations.

The time is not far distant when the old-fashioned alkali works, where human creatures are burned and tortured, will be replaced by healthy factories; where, instead of fires and boiling pans being used, electrolytic tanks will do the work quietly and cheaper, and where even the concentration of the caustic will be effected by electrolysis.

But we must be steady, modest and patient in our work. As it is commonly said, we must walk before we run and dance, and ambitious people or dreamy speculators only can speak of the alkali industry being dethroned and compelled to disarm and to adopt the manufacture of chlorine and caustic soda by electrolysis.

No doubt the attention of the papermakers and of the bleach and alkali manufacturers has been aroused by the progress of electrolysis during the last few years, but there must be no delusion about their plans. They are fully aware of the magnitude of the profits to be derived from the applications of electrolysis, and they may have made up their minds to avail themselves of the advantages of electricity, but they are too wise to take a decision before finding a process more practical and economical, and less questionable than the Richardson and Holland process.

## ENERGY AS A FUNDAMENTAL IDEA.

By E. TREMLETT CARTER.

IN the ELECTRICAL REVIEW, Vol. xxxii., page 495, there is an interesting note on the suggestion made by Prof. Ostwald, that *energy* should replace *mass* among the three fundamental quantities which are the basis of the C.G.S. system of units. Taken in conjunction with a recent leader in the ELECTRICAL REVIEW, which deals with Hospitalier's suggestions for re-modelling the system of electrical units, this idea of Ostwald's is worth investigating. We will, in the first place, survey the grounds of the proposed change. Space and time must ever remain fundamental, subjective conceptions; and no other quantity can be discovered by which they can be more simply expressed than in terms of themselves alone. In dealing with them we are necessarily dealing with the inner world of thought, rather than with the outer world of conditions underlying phenomena. Mass, however, is not so essentially fundamental to thought, and serves the purpose of a stop-gap in the evolution of the idealistic notions of the outer world. Still, the hypothesis—for it is nothing more—of the indestructibility, the conservation, of matter has led to mass being assigned a prime place in physical science; while the evidence of our senses has invested all phenomena with the same basic quantity. During the last two or three decades the progress of science has developed, slowly but surely, the conviction that matter, *per se*, is nothing, that *energy* is everything. First came the doctrine of "the correlation of the physical forces," by which was intended that they all were mutually convertible; and the discovery that the vehicles of sensation—light, heat, sound, elasticity—are all forms or functions of energy. Rapidly following, came the discovery of the equivalence of the various forms of energy, which led to the doctrine of the conservation of energy, a doctrine as firmly established as that of the indestructibility of matter. Science thereby entered into the not altogether comfortable possession of two equally fixed things in the universe, energy and matter; and the "white elephant" which it had acquired began to show itself when it was found that neither of these two things could be defined or accurately thought about without the other. The inevitable tendency which this produced may be seen in the discoveries of Newlands, Mendelejeff, and Meyer, and in the hypotheses of matter and energy which have been put forward by Thomson and by Crookes. Matter and energy are but functions of one another and, perforce, of some unknown thing which is simpler than either; all energy is one, all matter is one. Such is the present limit of speculation and hypothesis about the physical universe; and it leaves us with as much right to formulate our ideas in terms of energy as of mass, of either as scientifically as of the other.

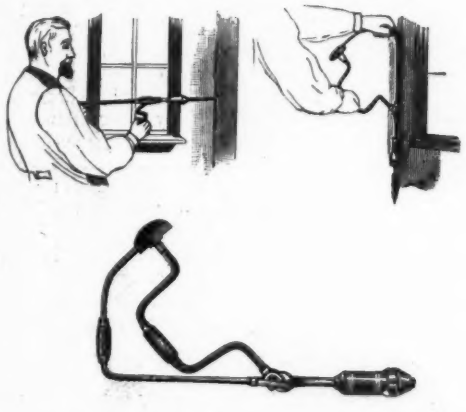
So much, then, as to the scientific right to supplant mass by energy. It is another story when we try to discover if it will be *convenient* to do so. All our physical knowledge may be expressed either in terms of space, time and mass or of space, time and energy; but the whole of that knowledge is derived, initially, through sensation. By touch, sight, smell, &c., we get hold of a bundle of ideas which, whether we treat them according to Berkeley or according to Hume, compel the notion of an inexplicable, tangible something, a material presentment—*mass*. Do our senses as readily assist us to form a conception of energy? Is the conception of energy which we derive from them as fundamental, as primitive, and as simple? If so, we may with equal convenience construct our physical science upon either basis. If not, we may no more reasonably make our conception of energy the basis of our knowledge of matter than we may teach simple arithmetic by the rules of the integral calculus. If we analyse our primitive ideas and sensations, to see if they yield as readily a notion of energy as of matter, we shall, I think, be compelled to admit that they do not. It is the advanced scientist who thinks in terms of energy; the beginner is obliged to think in terms of mass.

Conceive, for example, a system of elementary science based upon the proposed change. The student starts with definitions and ideas of time and space; he then proceeds to a more or less tentative definition of energy. He must next construct a definition of force apart from mass, and must derive the notion of force from the three quantities that have been selected. To do this would be difficult, perhaps impossible, for a beginner; but what shall be said of his attempt to get a notion of *mass* from this complex idea of force and the three other ideas? Work could no longer be explained as "foot pounds," and the horse-power would be metamorphosed entirely; while the zenith of difficulty would be reached when he attempted to find out what was meant by a pound weight! All this topsy-turvydom would arise from the futile attempt to proceed from the complex to the simple; from the desire to express the element in terms of the compound which it partly forms. Assuming, for the sake of argument, that the beginner struggles through and gains an advanced knowledge of physics, he would find his new pattern of thought only on certain occasions more useful to him than the old and discarded one. In tracing the path of a fixed amount of energy from system to system of material particles, it would undoubtedly be advantageous to have a set of ideas which fixed the mind fundamentally on the energy rather than on the matter; but in studying the action of a varying flux of energy out of or into a fixed system of material particles, it would be more than confusing to find that every idea had to be treated in terms of the secondarily important and ever-changing quantity, energy. To engineers, the new system would come as no help whatever in dealing with the theory or practice of machinery; while the inversion of ideas which would arise from its adoption would produce a revolution which would be a long while in settling down to order and quiet. Only the advanced scientific world, the world of research and speculative thought, would benefit by the change; and, to this, it would be without doubt a boon indeed. But, in an

informal and private manner, each one for himself, that world has already made the change ; the leaders of scientific thought no longer think along the trammels of the old material science ; to them, energy is equally if not more important than matter as a factor in the scientific idea of physical phenomena.

## AMIDON'S CORNER BRACE.*

THE accompanying cuts represent Amidon's corner brace, and show the applications in which this tool is particularly useful. Wiremen will appreciate the features of this brace. The Amidon Tool Corporation, of Buffalo, N.Y., its manufacturer, claims that this brace bores fully 10 to 20 times as fast as the ratchet brace, as the movement is round and round. It bores also very much easier, for two reasons : It is easier to turn round and round than back and forth, and the pressure coming on the arm of the brace instead of the sweep itself more power is gained. For heavy work or boring into hard wood, but especially for boring overhead, which is very severe work, either in a corner or in the clear, the superiority of the corner brace is apparent in the advantage gained by the pressure on the arm. In boring in the wall at the floor this advantage is highly appreciable, as the foot can be used against the arm with good effect. The corner brace, however,



is not confined to work in the corner or against a wall, but owing to the advantage just mentioned in the arm it will do much easier and just as good work in the clear as an ordinary brace. It will bore close into a corner ; the ratchet brace, owing to the head, will not bore a straight hole within an inch and a half of the corner. In removing the bit and clearing the hole time is also saved, as the ratchet brace must be worked back and forth, as in boring. In hardwood boring the bit is often loosened from the ratchet brace in the backward movement which cannot be the case with the corner brace. With the corner brace a straighter hole can be bored than with any other brace, as the eye is easily guided by the straight rod, at the end of which the bit is held. The corner brace will not cripple by springing (bending) the sweep from heavy work, as the pressure, being on the arm, bears directly down upon the bit and not on the sweep.

## LONG-DISTANCE TRANSMISSION OF POWER.

IN treating this subject before the National Electric Light Association of the United States, Mr. C. S. Bradley is carried away at the outset with the immensity of the idea of producing all our energy in the country for use in the cities, whereby the cities are to become exceeding desirable places of residence, free from smoke and foul gases, all of which are to be thrown off where they will do no harm, to wit, in the country. We remember that *Punch* once depicted the first awakening of a jaded city man who had retired to a farm house for a quiet holiday and whose early morning view was of a thrashing engine in full play in the stack yard, with all its customary whirr and hum. We are reminded of this by some of the later schemes of transmission.

Those who live at the coal pits will then not merely dig our coal for us but will burn it and breathe it. Happy countryman ! as though the coal fields have not already their fill of dirt. However, when long-distance transmission has been perfected, we may hope smoke also will have been conquered.

As a basis of computation, we are presented the gas engine at 72 per cent. efficiency and a transmission effect of 75 per cent., giving 54 per cent. of the coal energy delivered for consumption. We are first, however, to rob the coal of its *chemicals*, these, of course, being only the chemicals of the drysalt man, and we are left for use the gas.

Whence, however, is obtained the efficiency of 72 per cent. for the old Otto and Langen free piston gas engine, which, we are informed, has been obtained. This would be double the efficiency of the best compression engines, and even if so high an efficiency as 72 were obtainable, this could only refer to the manufactured gas and not to the coal, a portion of the energy in which is lost before the gas reaches the engine. The low efficiency of the steam engine is due to the fact that it works between temperatures of small absolute difference, and does not receive its heat at the maximum temperature at which the heat is generated—that of the furnace. The gas engine does receive its heat at the maximum, for the furnace is contained in the working cylinder, but the gas engine differs from the steam engine in that the latter uses the heat which the gas engine rejects, and the gas engine uses the heat which in the steam engine goes up the chimney. In both engines there is a furnace and a boiler, but the boiler of the gas engine is the water jacket round the cylinder, and until means are found to get along without this cold jacket, the gas engine must remain at a low efficiency. While we are dreaming of the electrical future, we are surrounded by gas engines all putting heat into water which is run to waste and by thousands of domestic fires kept alight for water-heating purposes.

So long as we must generate electricity by power derived from engines of low efficiency, whether gas or steam, will it be really cheaper to keep our central stations near enough to the centres of population to enable use to be made of waste heat, for, given that such waste is used on the spot by the placing there of our manufactories, what then becomes of our cities ? Some genius remarked that the big rivers always seemed to run near the big towns, which he thought very fortunate. The central station problem in the country comes fairly into parallel with this if we are to move faster than our knowledge leads. We seem, however, to find ground again below our feet when Mr. Bradley instances the Lauffen-Frankfort plant. It is on such as this that our long-distance experiences must be obtained, for it was from water that the power was there generated, and while the great falls of America and Africa are going to waste, there is a height of ambition to be reached in long-distance transmission before which every other scheme appears as nothing.

Our author looks on the Frankfort scheme, however, as very much ahead of anything to be expected in practice for some time to come.

For the generators in a long-distance scheme he would use 500-volt machines in series, all belted from one shaft and of an ampère capacity such as the size of plant demanded. In the end machines where the terminal voltage may be, say, 20,000, the windings could not be insulated against such a piercing strain. To avoid this, he would connect the windings of all the machines with their frames, so that no part of any machine could vary in potential from any other part. He then insulates each machine foundation from the ground by means not explained, but in a cheap manner stated to be so perfect as to avoid all derangement. To ensure the safety of attendants, each machine is to be surrounded by a platform of wood sufficiently wide to prevent anyone forming a connection from the machine to any object off the platform. On long lines, Mr. Bradley leans to the use of direct current, but for shorter distances to the alternating current, and the lines should be carried on poles wherever possible, so that inductive effects may be minimised.

C

* *Western Electrician.*

In the generator station compound-wound machines are preferable, first, that the system may be self-regulating; secondly, that when a machine is thrown into action the series coil shall magnetise the field in the right direction, which requires that the switch shall close the series coil first. A shunt coil would tend to reverse until the machine had attained sufficient E.M.F. to overcome the resistance of its own armature. About the chief difficulty in the alternating system is the static induction due to the enormous surface of the long lead. At Lauffen the line was intended for 300 horse-power and 40 phases per second, but had to be lowered to 23 phases, which necessitated the dynamo being run only at 100 horse-power; this increased the proportionate static effects, these being dependent upon the surface of the wire, while the carrying capacity is dependent on the area of cross-section. The line was so much occupied with the ebb and flow of current that he had seen the fuses blown at Lauffen with no load of consequence at Frankfort. Wetness of the insulators increased the difficulty by providing extra surface. The Lauffen-Frankfort was an extreme case, as above explained, and each case must be separately determined to minimise such effects. Though he evidently believes in long-distance transmission, Mr. Bradley has an eye to the difficulties, which augurs better for future development than an unthinking enthusiasm.

## ARC LIGHTING.

By E. TREMLETT CARTER.

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### I.

ELECTRIC lighting by means of arc lamps is a distinct branch of electrical engineering. In many important respects it differs from glow lighting. The character of the light, the form of the lamps, the arrangement of the lamps in the circuit, the design of generating plant, each and all differ in the two systems of lighting. Yet, while the glow lamp has received abundant consideration at the hands of authors, and all the plant involved in its use has been fully discussed, there is but scant literature on the arc lamp, and the methods of lighting by means of it.

There is no mechanism, says *Industries*, used in electric lighting so little studied as the arc lamp. The average electrical engineer knows less about the underlying principles and the actual working of arc lamps than of any other part of his business. No good work has been written on the subject, the nearest being an able paper by Prof. S. P. Thompson. The full theory of the arc lamp, and the design of dynamos and arc lamps to work on series circuits, have never been discussed. The properties necessary for success in parallel running have never been formulated. The alternating arc lamp has received even less attention. All this is, apparently, because some 10 years ago it was the fashion to talk of arc lamps as out of date in comparison with the more modern incandescent lamp. Here we have a comparison drawn between two lights which cannot be said to compete, because neither can replace the other. The incandescent lamp got the best of the foolish battle, and the arc lamp has remained very much where it was 12 years ago. The senseless feud between the advocates of alternating and direct currents is now producing equally disastrous results. It is quite time engineers studied arc lamps seriously, designed them to suit modern distribution systems, and arranged them to burn cheap carbons without "pumping," and without getting out of order. Mr. Crompton prophesies a great future for arc lamps, and it is certainly curious that the arc is least used in the only country where the incandescent lamp is expensive. Insular prejudice—or, what is much the same thing, insular ignorance—is still extant in this country.

In the present series it is proposed to deal exclusively with machinery connected with arc lighting. The principal conditions of the circuit will at first be explained. A knowledge of these conditions is essential to the proper understanding of the rules for designing the various details of machinery. Subsequently, the principles and rules adopted in the design of generators, transmissive plant, and various types of lamps, will be severally discussed. Arc lamps for special purposes, requiring as they do special precautions in their construction, will be considered separately. In conclusion, the various photometric and other tests connected with the subject will be dealt with. We may remark at the outset that all the principles which will be discussed, the rules which will be laid down, and the types of machinery which will be described, will without exception be of the most modern character. It is the writer's hope to be able to furnish a practical engineering treatise on the subject, rather than a popular review or a dusty history of antiquated apparatus. With these few words of preface, we commence our study of arc lighting.

#### I.—*The Conditions of an Arc Light Circuit.*

1. *The Electric Arc.*—When two rods of carbon are maintained at a potential difference of about 50 volts, and are brought into contact at their ends, a strong current passes through them. In proportion as the pressure of their contact surfaces against one another is reduced, there will be an evolution of heat at this contact; so that by gradually drawing the rods away from one another, the heat at this place will become so great as to vaporise a little of the carbon. Intensely heated vapours are better conductors than cold, dry air; so that a voltage which in the latter case would be unable to maintain a current after contact was broken, will now, on account of this carbon vapour, be able to keep the current passing. Still, the resistance of the carbon vapour is enormously greater than that of the carbon rods, and the effect of this is to cause almost all the electrical energy to be dissipated as heat within the mass of the vapour. Owing to the small mass and the low specific heat of the vapour, this large evolution of heat causes a very great rise in temperature; in fact, a temperature is reached in the centre of the vapour which cannot be attained by any other artificial process. Intensely hot vapours are, however, non-luminous. Though hotter by far than the hottest known solid body, they give out little or no light. Only the solid and the liquid states enable a body to become luminous, so that the intrusion of some solid body into the mass of heated vapour is necessary before any light can be obtained. Such a solid body is supplied by each of the ends of the carbon rods, and the immersion of these in hot carbon vapour causes them to glow with a light of great intensity. The continuous passage of the current keeps up the supply of heat, and compensates for the constant radiation; but the heat which produces the light is always generated in the vapour, and is afterwards taken up by the solid carbon ends.

If the above experiment is tried with a very low potential difference, say, with 10 volts, it will be found that only a brightly luminous spark occurs at the moment of separation of the carbons—no continuous light can be produced. This momentary spark characterises the breaking of contact for any potential difference under about 40 volts; but when this voltage is reached, a constant current passes after the separation of the rods, and light is continually produced. As the voltage is further increased, more and more vapour is generated between the rods, and the area of luminous carbon surface is extended. The intensity of the light is not, however, augmented, and by no alteration of the current, or the distance of the rods from one another, can the light evolved from unit area of that surface be increased beyond a certain point. The character of the light, the exact composition of it, is independent of the intensity of the current, and of the area of incandescent surface. These remarks apply, of course, only to that surface which is at the full degree of incandescence, and not to the edges of the heated rod where rapid cooling is lowering the temperature. This fact points to the conclusion that the temperature of the white hot rod is constant for all sizes of arc and for all exciting currents, provided the incandescence is steady.

In conjunction with the above important fact, we may consider two others. The first is, that the current which passes through the carbons is not simply proportional to the voltage from zero, but proportional to the excess of the voltage above, about 39 volts. This looks as if there were a back E.M.F. of 39 volts in the arc; and it will be convenient to consider that there is such. The second fact is, that the electric arc may be produced by means of rods of other conductors besides carbon. Any metal will produce

an arc, if two surfaces of it carrying a current are separated. But in every case there is a limit to the degree of light which can be obtained from unit area, and to the minimum voltage which will give the arc, as well as to the character of the light, which is peculiar to each substance. These facts, taken together, lead to the conclusion that the cause of the back E.M.F. is the latent heat of the vapour, and the limit of incandescence the temperature of vaporisation.

2. *Efficiency of a Light Source.*—The electric arc differs in no essential from the general mode of producing artificial light, for all such is developed by the wasteful process of causing heated bodies to become incandescent. A hot body is a body in a state of molecular agitation; molecules in agitation cause waves in the ether to radiate from the molecules as centres—the energy of these waves is called radiation or radiant energy. The hotter a body becomes, the more quickly do its molecules vibrate and oscillate to and fro, so that the hotter the body is the greater will be the frequency of successive waves. Owing to the disorderly nature of the molecular motions, the waves will not all be of the same character; some will follow in rapid succession, some less frequently. From every hot body there is thus set up a composite radiation. With every accession of temperature, new waves of higher frequency are added to the general disturbance, superposed, as it were, on the former ones; and, at a certain point, these new waves are rapid enough to affect the eye. Then the radiation is luminous; light is emitted. But not all the radiation is in the form of light; only that portion of it which is able to affect the retina is visible. In general, the hotter the body becomes, the greater becomes the percentage of visible or luminous radiation, so that an efficient source of light is one which is at a high temperature. One of the conditions desirable in the arc is therefore a high temperature, and this can only be obtained by the use of rods of some material which has a high vaporising point. No known substance has a higher vaporising temperature than carbon.

3. *Consumption of Carbons.*—It is found that the two rods decrease in length as long as the arc is maintained. If the current is alternating, the rates of decrease are equal; if continuous, the rate of decrease of the positive rod, or that from which the current enters the vapour, is, roughly, twice that of the negative rod. In the former case, the positive and negative ends have the same shape, and neither of them is hollowed away. In the latter case, the positive carbon is hollowed away at the end, forming what is called a "crater," and has a blunt termination; while the negative rod becomes sharpened to a peaky point. The explanation of the difference which is caused by a continuous current is as follows: at the positive point an electrical vaporisation of the carbon occurs, the latent energy being supplied by the current overcoming a back E.M.F. at this place. This hollows out the end of the rod and produces the crater. It is possible that a portion of the vapour is condensed on the negative carbon, where its latent energy would be given up as heat; the rest, or possibly the whole of the vapour, will burn in the outer envelope of the arc, where it is in contact with oxygen from the air.

The writer has pointed out that a peak must be formed on the negative carbon, owing to the fact that its inner portion is immersed in carbon vapour, while its outer surface is in contact with consuming oxygen. The outer part would burn while the inside would remain, thus forming the peak. The fact of these differences in the ends is of some importance in designing lamps. To obtain steady light and uniform consumption, the rods must be adjusted to the right distance apart, and must be continually fed towards one another to maintain this distance. Too short arcs are sure to hiss and flicker, and will deposit "mushrooms" or loose sooty lumps of carbon on the negative end. Too long arcs are liable to be blown out or to go out of themselves, and may flicker on account of irregularities in the density of the carbon. The usual distance for ordinary sizes of arcs is about $\frac{1}{8}$ to $\frac{1}{4}$ inch. At this distance the positive rod emits about 85 per cent. of the total light, the negative 10, and the carbon vapour 5 per cent.; while an average of 50,000 candles is emitted from each square inch of fully incandesced carbon.

4. *Systems of Arc Lighting.*—There are several possible systems of arc light distribution, and the design of the machinery will depend upon the system which may be chosen in any case. It will be convenient to consider (*a*) series and (*b*) parallel distribution, with both continuous and alternating currents, and (*c*) parallel transformer distribution with alternating currents. Besides these, circuits for single lamps must be considered. Each lamp, however it may be arranged, will require a certain definite voltage at its terminals in order to get the proper current through its arc. If arranged in series with others, the voltage of the entire circuit will vary with the number of lamps at work, while the current will be kept constant, and will pass *seriatim* through them all. If arranged in parallel, the voltage of the mains all along the line must be kept as nearly constant as commercial considerations will permit, however many lamps may be at work; while the current in the mains will be proportional to the lamps at work.

II.—*Design of the Circuit Details for these Conditions*

5. *Series Systems.*—As regards the design of the mains and circuit details, whether considered from the point of view of economy or of satisfactory running, the series system is the one best adapted to arc lighting. It may not, at first sight, be seen why this should be so, since the opposite is the case with glow lamps. The reason lies in the fact that arc lamps require a large current at rather low voltage, and are provided with their own controlling gear, while glow lamps are usually designed to run at higher voltages and take less current, and are not conveniently provided with mechanical gear. The series system has its limits, however, and where the number of arc lamps is large, or where they are distributed over an extended area, the transformer parallel system is more suitable and economical.

Assuming that the generators are capable of keeping a strictly constant current in the mains at all loads, we may proceed to design the mains. We have only to consider the prime costs and the working losses, for, whatever size of cable is adopted, the generators will be designed to send the right current through it. It will first of all be necessary to draw a plan of the circuit, accurately measuring off the length of cable which will be required for each arc lamp, care being taken to arrange the cables along the route so that all the lamps are included with the least possible length of cable. If there is a great length of cable per lamp, it will be necessary to adopt a rather high density of current per square inch section of copper, while, if the lamps are close together, we may afford a larger cable. To finally determine the size of cable we must further determine the load factor of the circuit, the price of one horse-power year, and the cost of laying an additional unit of cable plant. With arc lamps it is rarely difficult to determine the load factor. In the case of street lighting, or of factory lighting, it is known beforehand how many hours the lights will be on during the year; while, in the case of single private arcs, another system of supply is usually adopted. But even where arcs are supplied to shops from a generating station, and a special series system of cables is put in for the purpose, it will usually happen that arrangements are made for keeping the current on the mains during a definite number of hours each day. It will generally be possible to determine or to infer fairly closely what load factor may be expected. The estimate of cost of one H.P. year must be made for that amount of energy supplied either at the lamps or at the meter, if there is one. This estimate is one of the most difficult to make, as the extra losses due to working at low loads, and to leakage, &c., are difficult to ascertain. In practice, however, it may be determined to a sufficiently close approximation. The cost of laying an additional unit of cable plant may be obtained from a knowledge of trade prices, freightage, and wages rates. Thus, if one ton of copper costs a certain amount, and the extra insulation which it will involve costs another sum, while the extra on freight of the total additional weight *plus* the additional sum in wages for laying a heavier cable, costs a third amount; the total of these three sums will be the required additional cost per unit of plant. Having made these estimates within that degree of accuracy which the conditions of the problem allow of, we now apply the law of economy to determine the best section of copper. According to this law, the best section of copper is that at which the annual interest of the capital required for an additional unit of cable plant plus the depreciation of that additional plant, is equal to the annual cost of the power which its use would economise. In its most usual form:

$$a = c\sqrt{\frac{w \cdot q \cdot t}{p \cdot k}} \text{ square inches,}$$

the law is difficult of practical application. Here, $q$ is the cost of one electrical horse-power hour at the dynamo terminals, $t$ is the time of running in hours throughout the year, $p$ is the percentage rate of interest, and $w$ and $k$ are constants; the maximum output being denoted by $c$. It is to be noted that the difficulty in applying the law in this form lies, chiefly, in determining the constants $w$ and $k$, as well as in the fact that if the current, $c$, is not used for the whole time, $t$, a modification becomes necessary. It requires but a little alteration to bring the form of the equation within practicable working details, when the section of copper is represented by the following equation:

$$s = 0{\cdot}873 \cdot c\sqrt{\frac{w \cdot z \cdot f}{p \cdot k}}.$$

In this, the important electrical quantity, the load factor of the mains, is directly applied; so that engineers, who are, as a rule, fairly accurately informed as to this quantity, can employ it in designing the mains. The several quantities in the equation are: $f$, the load factor of the mains in percentage of the full year at which the full current, $c$, is carried through the mains; $z$, the cost of one electrical horse-power year at the dynamo terminals, the full year of 8,760 hours being taken; $k$, the cost, in the same units, of additional plant per square inch section of copper in the main for any convenient length of cable; $w$, the energy wasted per hour per square inch of section of copper, with a current density of 1 ampère per square inch in Board of Trade units, the same length as in $k$ being taken; $p$, the percentage rate of interest and depreciation per annum; the section of copper, $s$, being given in square inches. Referring again to the load-factor, it must be noted that in a series system this quantity is simply the ratio of the number of hours during which current is passing through the cable to the total number of hours in the year, and is independent of the variation in the number of lamps. This will be evident when it is remembered that the loss of power is proportional to the square of the current, which in a series system is constant. On this account the application of the economic law is very much simplified, as it is only necessary to know the number of hours per annum during which light may be required. By means of this arrangement of the formula, an engineer can calculate the section with the data for any length whatever, such as a yard, or a mile, or 1,000 feet. For example, let it be required to determine the most economical section of copper to transmit 50 ampères, having given that the cost of 1 E.H.P. year at the dynamo terminals is £21 15s.; that the cost involved in adding to the plant would be at the rate of £189 6s. per 1,000 feet of cable per square inch section of copper added; that the rate of interest and depreciation may be taken at 7½ per cent.; and that the load factor of the line will probably or certainly be about 46 per cent. We will suppose that the copper is of such a quality that the working resistance per square inch section and per 1,000 feet run is 0·00853 ohms; so that this figure divided by 1,000 represents the value of $w$. We then have

$$s = 0{\cdot}873 \times 50 \times \sqrt{\frac{0{\cdot}00000853 \times 21{\cdot}75 \times 46}{7{\cdot}5 \times 189{\cdot}3}} = 0{\cdot}1325.$$

This is equal to a current density of about 377 ampères per square inch of copper. If the load factor had been only 11½ per cent., which it is in many electric light mains, the theoretically economical section would have been ·0663 square inch, or a current density of about 755 ampères.

It will next be necessary to consider some cases where the above law is inapplicable, or where its results must be considerably modified before they can be used.

*(To be continued.)*

**City and South London Railway Extension.**—The two Bills promoted by the City and South London Railway Company, one for powers to extend their system to Islington, and the other to extend the time for completing their extension to Clapham, came on Tuesday as one consolidated Bill before the Examiner of the House of Lords, who decided to allow the consolidated Bill to proceed.

## ELECTRICITY IN METALLURGICAL OPERATIONS: LABORATORY FURNACES.

BUT a short time ago, we hazarded the opinion that in the future the only function left for coal gas to perform would be the supplying of heat. Already its original function as an illuminating agent has been wrested from it, and now so quickly do we progress, that its position as a thermal agent is being challenged. The most enthusiastic advocates of the general use of electricity for supplying power, light and heat, are scarcely too extravagant in their claims: for that which is dimly foreseen to-day becomes an accomplished fact to-morrow. Within the past few months it has been completely demonstrated that electricity can not only generate an intense degree of heat, but that the thermal power thus supplied is capable of useful application; the most refractory substances which have hitherto withstood every attempt to reduce them, have been compelled to yield in the electrical furnace.

For assay work and general operations of this kind in the metallurgical laboratory, gas has hitherto held its own; but even in this field it will have to give way to electricity. Already the adaptation of the electrical current to these operations has been successfully carried out. In Germany, Herr W. Borchers, whose "Electrometallurgie" is one of the leading works on this subject, has elaborated some apparatus which will, we believe, replace all gas furnaces for metallurgical work. He gives a detailed account of several forms of electric furnaces, &c., in a paper which may be consulted in the *Zeitschrift für Angewandte Chemie*, 1892, pp. 133—136. In this paper, telling arguments are stated in favour of the use of the electric current in metallurgical laboratories which point to its convenience, its rapidity of action, its cleanliness and its efficiency, and the author then proceeds to give details of the construction of the apparatus, by means of which the thermal power of the current is employed.

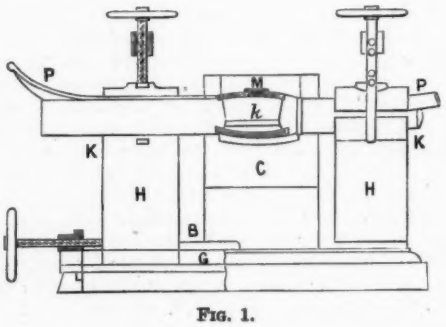


FIG. 1.

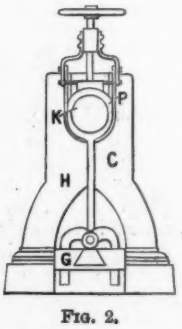


FIG. 2.

Figs. 1 and 2 give views of a form of furnace which is specially suited for roasting metallic ores. K, K, are carbon rods, about 25—30 mm. in diameter, connected by means of another carbon rod, 4 mm. in diameter, and 50 mm. long. This is enclosed in a muffle of fireclay or magnesia, M, which contains the ore to be roasted. The muffle is surrounded with powdered charcoal when it is desired to keep the ore from the oxidising action of the air; this also reduces the loss of heat by radiation, owing to its non-conducting properties. When, however, it is desired to heat the metallic substance under treatment in contact with the air, a fireclay trough, C, is provided, which serves to contain the open vessel

in which the substance is placed; it resembles the muffle, M, split longitudinally. H, H, are holders which carry the carbons, K, K; they play upon a slide, G, by means of which they can be brought and kept in contact by a spring or screw. The slide, &c., is protected from dust by the sheet-iron cover, B, and all the parts can easily be disconnected in order to facilitate cleaning. The leads which end in the copper plates, P, P, are clamped, saddle-wise, on the carbons, or attached in any other convenient way to the carriers, which are mounted on an insulated stand.

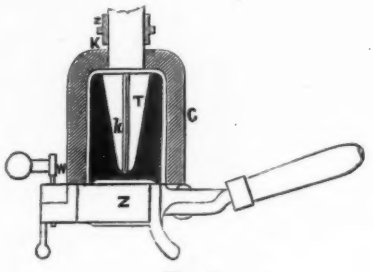


FIG. 3.

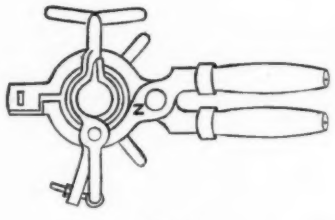


FIG. 4.

Figs. 3 and 4 show details of an apparatus which is specially designed for conducting fusions and reductions when the use of an iron crucible may be permitted. T is the crucible, and is supported by the iron clamp, Z, fastened by the key, W, and serving as a conductor of the current, as well as a support to the crucible. A carbon pencil, 4—6 mm. in diameter, serves to effect connection with the crucible, and a carbon rod, K, 30 mm. in diameter, which is carried in a clamp connected with the other conductor, in a manner similar to that described for the crucible itself. C is a fire-clay shield, with an outer sheet-iron cover, designed to protect the crucible, and check radiation. It is provided with a small opening, through which the progress of the operations can be observed.

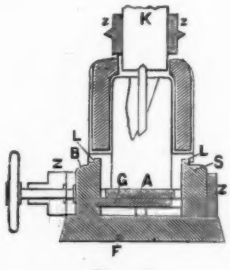


FIG. 5.

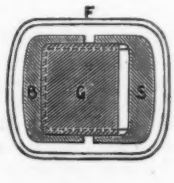


FIG. 6

When very high temperatures are desired—that is to say, when very refractory substances have to be dealt with, the furnaces shown in figs. 5, 6 and 7 are most suitable.

The crucible is set upon a cast-iron stand, which consists of a bed-plate, F, with side pieces, B, S, the latter of which are movable and can be brought up towards B by the wrought-iron band, Z, which is worked by means of a screw or spring. In both the side pieces, B and S, a small groove is cut for the reception of the iron plate, G, upon which is placed a slab of asbestos or fire-clay, A. Rings of gun-metal, &c., may be used in order to make crucibles of different sizes fit; one of these is shown at L (fig. 5). Another device for the same purpose is shown at fig. 7; it consists of a series of springs, E, E, made of strips of metal, 5 mm. wide and 1 mm. thick; these make connection with the crucibles and serve to support it.

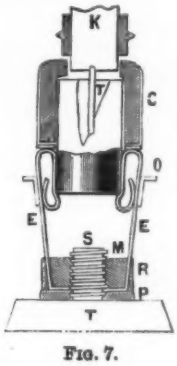


FIG. 7.

These forms of electrical furnace require very simple management. The only precaution necessary being to turn on the current gently, and not to exceed a current density of 5 ampères per square mm. of the cross section of the carbon rod embedded in the charge. For ordinary purposes this current density is ample; when it attains 6 ampères per square mm., a temperature sufficient to reduce alumina is attained.

In the paper in which Borchers describes these apparatus, he gives various experimental data. He found that with commercial carbon pencils an E.M.F. of 0·3 volt is necessary to send a current of 1 ampère per square mm. of a carbon pencil 10 mm. in length. In dealing with a very refractory substance, he observes that a carbon 4 mm. in diameter and 45 mm. in length was used, with a current of 60 ampères and 8 volts, *i.e.*, 480 watts, corresponding to an expenditure of 0·8 of a horse-power. Other data are given, for which the original paper must be consulted.

## SAYERS'S IMPROVEMENTS IN DYNAMOS.

THE ordinary continuous current dynamo seems still to be the subject of interest to many inventors, and there is a continual striving after some improvement to secure another one per cent. in efficiency, this more especially by the theoretical inventors; the practical men seek to improve the machine by mechanical devices, rendering the machine more durable and reliable. Dynamo field-magnets, series winding, shunt winding, and compound winding, armature reactions, conditions under which no sparking occurs, have all been ably and thoroughly investigated, and treated fully in papers read before societies. Yet, in practice, we find in large machines—more especially in large multipolar machines—that the commutators are never entirely sparkless, and that they wear away and require occasional machining by lathe tools to keep them in order.

Sparking is attributable to many causes now pretty generally understood by dynamo builders, and in designing dynamos these are carefully kept in view. The causes of sparking most difficult to control arise from the armature reaction, and, in multipolar machines, from unequal induction through the various magnetic circuits. The first of these has hitherto been controlled to some extent by designing the machine with a long air space, and by dividing the pole pieces; the second can be controlled only by an almost mathematical precision in construction.

Sayers's improvements are really the first attempts to tackle this subject from the "commutation" point of view. Others have attacked the problem and attempted to solve it by improved windings, or by improved magnetic circuits, or by some special collector brushes, but however much these devices may have improved the dynamo they never effectually cured sparking. Sayers's device consists in adding another winding to the armature and connecting it to the main winding and the commutator in such a manner that the currents generated in the additional winding tend to magnetise the armature in a direction to neutralise the ordinary armature reaction and magnetise the field. These currents also neutralise the current in the coils undergoing commutation, so that there is absolutely no sparking at the brushes. The magnetising effect is considerable enough to excite the field without any other winding, and if used with a shunt machine it requires no series exciting; these are valuable considerations, and it only remains to be seen whether these improvements are obtained without any drawbacks.

It seems to us that its chief advantages are obtained when applied to the Paccinotti form of armature, in fact, where the air space resistance can be made very low. It is doubtful if this device would be successful when applied to smooth armatures.

In the paper read before the Institution of Electrical Engineers the tables of tests given have all been made from dynamos with Paccinotti armatures. The application of the invention to a series machine used as a regulator is a very ingenious and a very useful application, to which, we have no doubt, it will be largely applied.

The paper is well worth studying as it treats of a subject not much discussed hitherto, namely, the actual process of commutation, and we agree with the author in his conclusion that it is abundantly clear that so far from having fully described what may be done by his device for bringing the commutation of ring and drum armatures under independent control he only touched on the border of a new field of design for continuous current machines.

## ROTARY MAGNETIC FIELDS.

BY ALEX. RUSSELL, M.A.

THE following theorem in elementary statics is of great importance in the application of graphical methods to compounding alternating electromotive forces and magnetic fields. If O $A_1$, O $A_2$ . . . (fig. 1) represent forces in magnitude and direction, and G be the centre of mean position (centre of

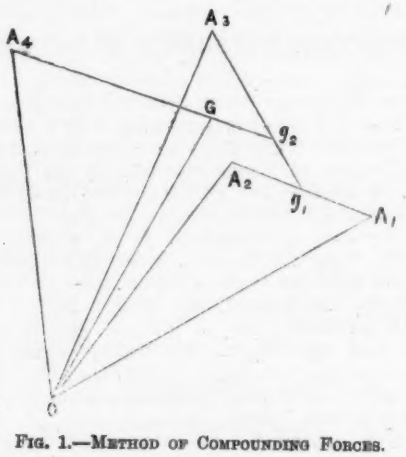


FIG. 1.—METHOD OF COMPOUNDING FORCES.

gravity) of the $n$ points, $A_1$, $A_2$, . . . then the resultant of the forces, O $A_1$, O $A_2$, . . . is equal to $n$ . O G, and acts in the direction O G. To determine the point G, we bisect the line, $A_1$ $A_2$ in $g_1$, then make $g_1$ $g_2$ equal to one-third $g_1$ $A_3$, $g_2$ $g_3$ equal to one-quarter, $g_2$ $A_4$, and so on. In practice simpler methods of finding G suggest themselves, depending on the number of points.

This theorem is also very useful for graphically compounding magnetic fields. Consider the case of a rotating field produced by $m$ equal poles, arranged evenly round an iron ring, the currents producing the poles differing in phase by $\frac{360}{m}$ deg. Let O be the centre of the ring, and suppose the strength of the field produced at O by each pole to follow the simple harmonic law, and to be represented by H sin $(2\pi n t + \alpha)$, where $n$ is the frequency of the alternating current. With centre O and radius equal to H (fig. 2),

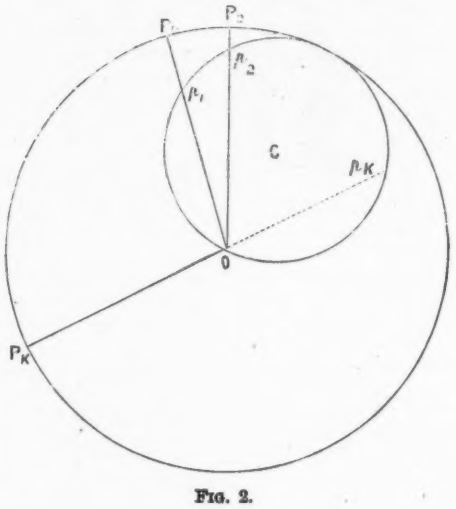


FIG. 2.

describe a circle, cutting lines drawn from O to the poles in $P_1$, $P_2$. . . Now, if a circle of radius, $\frac{H}{2}$, roll inside this circle, going $n$ times round it in a second, the lengths, $o\,p_1$, $o\,p_2$ . . . of the lines, O $P_1$, O $P_2$. . . . or those lines produced, intercepted by this circle will represent the component strengths of the field due to the poles, $P_1$, $P_2$ . . . Since $p_1$ $p_2$, $p_2$ $p_3$ all subtend equal angles at the circumference of the circle, it follows that $p_1$, $p_2$. . . . are all evenly distributed on its circumference and therefore form a regular polygon. Hence G in this case coincides with the centre of the rolling circle, and the resultant field is equal to $\frac{m}{2}$ . H, and rotates with uniform angular velocity $2\pi n$.

When the rotary field is used to drive an armature as in alternating current motors, the magnetising effect of the armature current has to be taken into account. Let (fig. 3) O B be the component of the magnetic field at O due

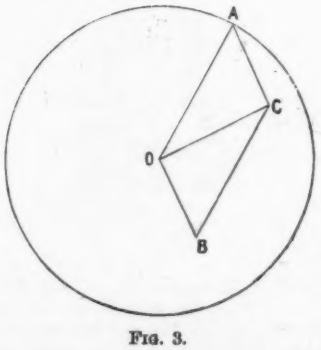


FIG. 3.

to the armature currents; O A, the strength due to the inductor circuit; then if O C be the diagonal of the parallelogram constructed on O A and O B as adjacent sides; O C is the resultant magnetic field. O B is at right angles to O C and is also proportional to it. Now, suppose the armature fixed and short circuited, O B is obviously a maximum in this case and the angle A O C ($\alpha$) can be calculated. If the armature now revolve $p$ times a second, the currents in the armature

are smaller in the ratio of $n - p$ to $n$, and the new angle, C O A, is given by the equation,

$$\tan \text{C O A} = \frac{n - p}{n} \tan \alpha.$$

Hence as the armature gets up speed the resultant rotating field gets stronger.

When the poles are unevenly spaced round the circumference, their phase difference being proportional to their distance apart, the nature of the rotating field produced can be very easily found. As before, let a circle roll inside another of double its radius and (fig. 4) let $o\,p_1$, $o\,p_2$. . . .

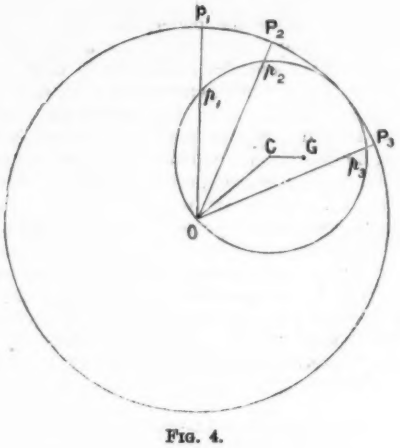


FIG. 4.

be the components of the magnetic field. Since $p_1\,p_2$, $p_2\,p_3$ . . . subtend constant angles at the circumference of the circle, the polygon, $p_1\,p_2$ . . . $p_m$, is of constant size and shape, G is therefore fixed with respect to the rolling circle. If C be the centre of the rolling circle it is easy to see that the angular velocity of G about C is double the angular velocity of C about O, and is in the opposite sense. Also $m$ . O G is the resultant field.

Let O X (fig. 5) be the position of O C and C G when they

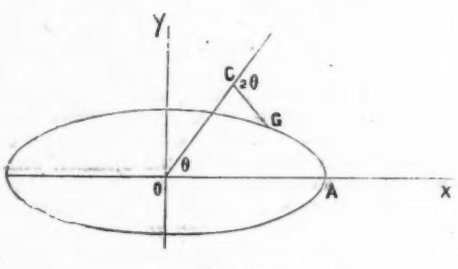


FIG. 5.

are in a straight line, C G = C, angle C O X = $\theta$, and let the co-ordinates of G be $(x, y)$, then

$$x = \left(\frac{\text{H}}{2} + \text{C}\right) \cos\theta\,; \; y = \left(\frac{\text{H}}{2} - \text{C}\right) \sin\theta.$$

Hence G lies on an ellipse whose axes are H + 2 C, and H − 2 C respectively.

The nature of the field can be shown mechanically by letting a circular disc roll inside round the circumference of a circle of double its diameter with uniform speed, an elastic string fastened to a point in the plane of the disc and to the centre of the larger circle, will represent the field in magnitude and position as the disc rolls round. We see that the angular velocity of O G is variable, being greatest when O G coincides with O Y, and least when O G coincides with O X.

It is proved in Thomson and Tait's *Nat. Phil.*, Part i., section 66, from elementary geometrical considerations, that the extremity of the resultant of any number of simple harmonic motions of one period, in all directions and of all phases, moves on the circumference of an ellipse, and that equal areas are described by this line in equal times. Hence, if H be the strength of the resultant field at a point due to inductor poles of all strengths and in all phases directed towards the point, and if $\omega$ be the angular velocity with which it revolves,

$$\text{H}^2\,\omega = \text{constant.} \qquad (1.)$$

Since the E.M.F. developed in the armature is proportional to H $\omega$, it varies as $\frac{1}{\text{H}}$, from (1), and is therefore greatest when H is least.

If the rotating field is produced by currents of different frequency, we get all manner of oscillating fields. Diagrams of the curves described by the end of the resultant magnetic

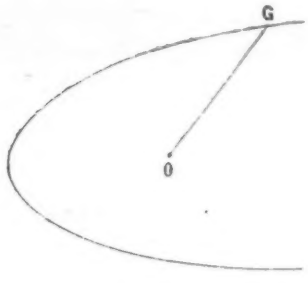


FIG. 6.

force are given in all works on the theory of sound, under the head of Lissajous's figures, and various mechanical devices are described for getting these figures.

If the field is produced by two currents, the frequency of the one being double that of the other, their epochs being the same or differing from one another by a multiple of $\pi$, we get a portion of a parabola (fig. 6), the curve being gone over twice in opposite directions in each complete period.

## PRACTICAL NOTES ON THE STEAM JACKET.

MR. W. FLETCHER discusses the vexed question of the steam jacket in *Cassier's Magazine*. Mr. Fletcher has been discussing jackets for many years. He was full of the subject when the present writer first met him some ten years ago, and yet it is doubtful if there be not still very good cause to continue the discussion. We constantly hear it stated that steam jackets are useless—worse than useless—and this is so strongly stated too, that we feel disposed to suggest that if a hot jacket be so very useless, it might be worth while trying whether a steam cylinder could be benefitted by a cold water jacket. Mr. Fletcher, however, has no ear for such arguments. He believes in jackets, but they must be filled

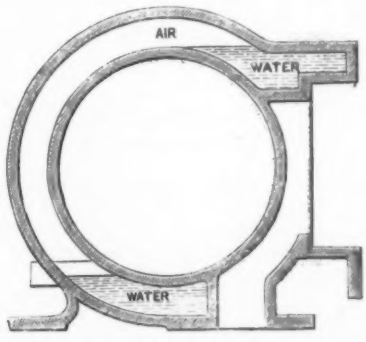


FIG. 1.

with steam, and not as often the case with air, water more or less hot or cold, or steam in a half dead condition, and he truly remarks that many who denounce jackets do not understand them. In practice, what faults of design are met with? There is the jacket which surrounds about two-thirds of the circumference of the cylinder; at the upper side water accumulates in the recess above the valve chest. See fig. 1.

At the lower side the drain cock is too high, and accumulation of water takes place there as well. There is no provision for proper circulation, and air gradually accumulates in the remaining space, and so far is useful only in that it protects the cylinder against radiation losses. To add to the evil effect of the two pockets of water, the exhaust passage lies against the unjacketed third of the cylinder, whereby much of the heat of the cylinder is transferred to the condenser without performing any useful work. Mr. Fletcher says at one time it was usual to jacket cylinders with exhaust steam, a practice not now carried out by deliberate intention, though still done in carelessness of design where the exhaust passages are not led directly away from the cylinder.

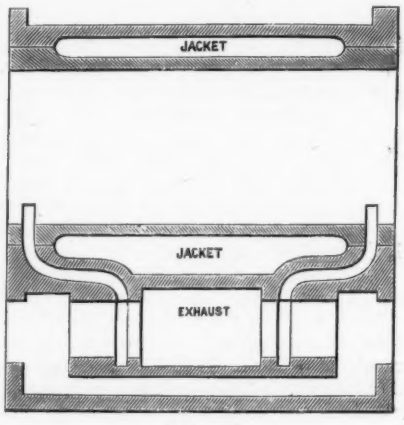


FIG. 2.

We believe that Watt ran the working steam through the jacket on its way to the cylinder, and we know from experience that many of the old beam engines in the north were thus jacketed, and it is said that such engines were thereby rendered more economical, though at first sight there appears to be merely a transfer of condensation from the cylinder to the jacket. It is, however, quite possible that the steam, in passing round the cylinder, which was of course vertical, cleared itself of any water it may have contained as a result of priming of condensation in the pipes, and to this the benefit of these jackets may have been due, but the plan is not to be recommended.

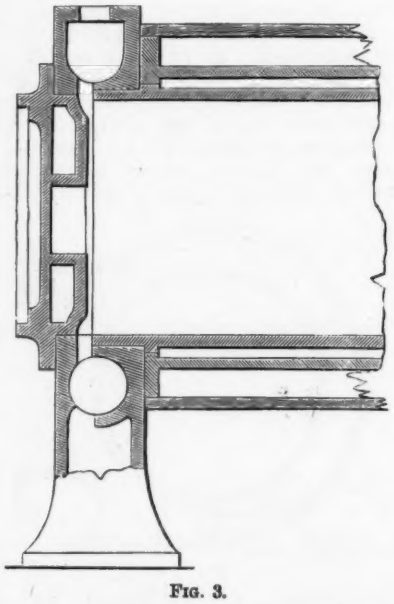

FIG. 3.

That the jacket should contain steam not below boiler temperature goes without saying. We have always contended strongly for more than this where possible, and are hardly disposed to accept Mr. Fletcher's statement that this can rarely be adopted. We think it might often be adopted.

We have often encountered instances where, in a battery of boilers, there has been one boiler smaller and stronger than the others, and we have recommended that this small boiler should be worked at its full pressure of 10 or 20 lbs. higher than the working pressure, and that the whole of the steam generated by this boiler should be passed *via* the jackets and a suitable reducing valve into the other boilers. There is no difficulty in this, and, with jackets free from water pockets, such a system absolutely compels circulation and prevents air from accumulating.

Unless this system can be carried out the steam admitted to the jacket can only be that corresponding with what condenses in it. There can be no true circulation without a free thoroughfare, and this must always go to reduce the legitimate action expected from jacketing. Even where the cylinder is well above the boiler, and drains freely back to this, there is always the risk of air accumulating in the jacket. Air is considerably heavier than steam at low pressures, but, being a more perfect gas than saturated steam, this difference diminishes as the pressure rises, but does not disappear at ordinary pressures. Air accumulation should, therefore, be capable of avoidance by means of a small return pipe to the steam space of the boiler from the lower part of the jacket, say, a couple of inches above the water drains. When heat is wanted for purposes of manufacture or heating, it would be well that some of the steam for such purposes should be drawn from the jacket. This precaution as to air should always be borne in mind, especially where the boiler feed is originally cold water. Hence the advantage of the often boiled water of the ordinary condensing pond from which the dissolved air has been pretty well stewed out.

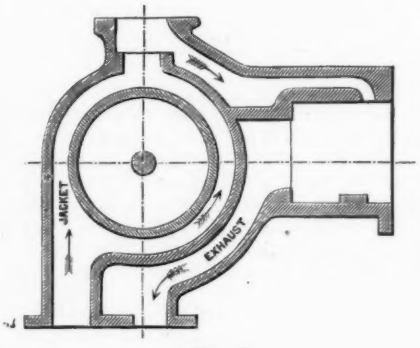


FIG. 4.

Closely allied to this steam jacket question is that of a dry working steam. If there be much priming there can be no question that during the exhaust stroke there must be great re-evaporation of the water left in the cylinder, with corresponding jacket condensation. What a jacket ought to do is, to evaporate all water condensed in the cylinder during the forward stroke. It is too much to expect it to act as a boiler of water which never even existed as steam in the boiler proper. Attention is drawn to the frequently extreme smallness of the jacket supply pipes. This is a mistake. The supply should be large, and should be direct from the boiler, and we are disposed to think that where thorough circulation cannot be had, it would not prove undesirable were a small pipe to be taken from the jacket to the valve chest. This latter, even in the best engines, is exposed to a slightly fluctuating pressure, and would therefore act to draw steam from the jacket, which should be at full boiler pressure. Though not desirable to feed a cylinder through a jacket, this small driblet would not have serious effect in the cylinder, but would be all powerful in drawing off any air from the jacket, that would in time choke it.

Naturally Mr. Fletcher favours thin working barrels, which can be secured by the use of steel liners, and he concludes with a warning to engineers not to accept test figures unless they are very sure as to the manner of man who has done the testing and the actual arrangement of the jackets, without which knowledge all such tests are worthless.

We reproduce the following figures from Mr. Fletcher's paper. Fig. 1 showing faulty jacket and exhaust passage. Fig. 2 showing a lined cylinder, but with the jacket in contact with the exhaust passage. Fig. 3, given as a good

example of a Corliss engine, where the jacketing is thorough and the exhaust is taken away direct. Fig. 4, where the working steam is all drawn from the jacket, and the exhaust is about as badly arranged as possible. It is much to be feared that numerous learned disquisitions have appeared on the behaviour of steam in the cylinder, which have been argued out with great array of mathematics from results whose true meaning has been entirely obscured by faulty construction. Papers like this of Mr. Fletcher's might well be kept in type and used at periodical intervals as corrective of that depravity of design which lends so much force to the arguments in favour of the totality of the specially human failing to go wrong where it is as easy to go right.

## JOEL'S ELECTROMOTORS.

WE have received a description of this motor, from which we gather that it can be worked by alternating currents, and has been for some time in use on ordinary alternating circuits for small powers up to about 1 horse-power.

There is, however, not much of novelty in the motor itself to interest our readers. Among the very first proposals towards constructing a motor for alternating currents, an ordinary continuous current motor in which the field magnets were laminated was brought forward, and such motors for very small powers have been quite common, and several of American manufacture are to be seen in show rooms driving ventilating fans. Mr. A. T. Snell, in his recent paper before the Institute of Electrical Engineers, dealt with this form of motor, and again pointed out its defects; for very small powers it may, in the absence of a perfect motor, be adopted; we fail, however, to see wherein any improvements exist in "Joel's" form of this class of motor. From the description it appears to be simply a motor on the lines of the well known Manchester type of dynamo machine, the field magnets being laminated. In the description itself, it is stated that the difficulties with alternating currents in these motors have been met, and to a great extent overcome, and this statement is made at the very outset. We therefore read through the description in the hope of ascertaining the precise methods by which the well known difficulties had been met, and to what extent they had been overcome. We find, however, that these interesting points are not again referred to in any way whatever; we find some references to an old patent, and an elaborate description of the stampings used for laminated fields and armatures, also to carbon brushes and regulating switches; but in all this there is no indication as to where the improvements are to be found in this motor over others previously proposed on the same principle.

The whole subject has been already so well threshed out by able electricians, and by direct experiments, the results of which are well known, that we do not care to find space for mere descriptions of very ordinary stampings, switches, dynamos, and well known applications of the same, illustrated by no less than 15 blocks.

Alternating current motors at present occupy the minds of many leading electricians; much progress towards the production of a perfect motor has been made, and from time to time we have laid before our readers the exact principles upon which improvements have been made, showing the steps in advance over previous attempts, and we shall continue to do so at all times when improvements are described to us, so that our readers can clearly gather their nature and extent.

## THE DAY LOAD.

THE question of the day load weighs still heavily upon us, and the practical solution of the problem seems to be as far off as ever. It has been claimed, with what at first sight appears to be a certain reasonableness, that the general adoption of motors on the lighting circuit would do something in the way of flattening the load curves. Motors, to some extent, have been tried, but it cannot be said that they have much furthered the matter. In the district of St. Pancras, as well as at Bradford, special terms have been offered to users of small powers, but, generally speaking, small users have shown no great disposition to avail themselves of electric current for power purposes. The question which arises in one's mind is whether the number of motors which can be placed safely on a lighting circuit is likely to be remunerative or not, for we take it that one cannot keep on increasing motors on a lighting circuit to any indefinite extent. Of course, if lighting and power could be kept quite distinct, there would be little objection to urge against the placing of motors on a lighting circuit, that is, if the current for power purposes was used only at the time it was not required for lighting, but such a happy state of things is absolutely impossible on an ordinary supply company's circuit. In London the supply companies are often called upon for a heavy supply of current for lighting purposes during the day, and under these conditions it is not difficult to imagine the effect of suddenly throwing off or on the circuit of heavy motors. Then, again, to utilise motors in a manner satisfactory to the users, the supply company ought to be ready to turn on current at any time, for it is well known that the man who uses machinery which can be driven by small motors is a man in a modest way of business, who, in the exigencies of his calling, is likely to want power at all hours.

It is obvious, therefore, that to be commercially successful, lighting and power must be kept distinctly separate from each other, and those who are endeavouring to create a demand for power purposes must be prepared to lay down separate mains. This fact has been fully recognised by the Southampton Electric Light Company in the case of the cranes at the Southampton Docks. These cranes are called upon at all hours of the day and night to do heavy work, and, under the circumstances, the only rational arrangement was to have special mains. This, of course, is a real day load, but it is not the day load for which central station engineers have long hoped. At the same time, it is a day load which fills up to the best advantage the idle hours of a central station, and will materially help the profits of any undertaking. The extra cost for mains is the chief consideration, and if this difficulty be surmounted, we think that a very useful and remunerative service would result.

It has been urged by many that the use of electricity in the household for purely domestic purposes would have a marked effect on the day load. The objects of the advocates for such a use of electricity are most praiseworthy, and their efforts should be appreciated, but we cannot go beyond the line that with cooking there might be an increased consumption, if we may use the term, the day load would not be seriously affected, because, as we have already pointed out, as soon as it is worth the while of a company to supply electricity for power purposes, they must be prepared to lay down fresh mains. It is difficult to see that electricity will compete successfully with gas for cooking and similar operations in the absence of storage. In the case of gas, there is a constant pressure in the mains without the necessity of running machinery, so no matter whether the demand be small or large, it would not affect the efficiency of the gas plant. It is very different with electric machinery, for to supply power you must run your machines no matter how little the load may be.

## REVIEWS.

*Formulaire de L'Electricien.* By E. HOSPITALIER. 11th year. Paris: C. Masson, 120, Boulevard St. Germain.

The general arrangement of this book does not differ from the previous edition issued, but several additions have been made with the object of bringing the work up to date, these additions chiefly relating to the applications of electrical energy. New tables of conductors, resistances, insulators, &c., are included. Central station work has been especially dealt with at greater length, also electric locomotion has received greater attention. The author proposes to considerably extend the portion dealing with electrical energy next year, when information obtained as the result of the Chicago Exhibition will be freely made use of.

We congratulate M. Hospitalier on the continued success of his compilation.

D

*A Guide to Electric Lighting.* By S. R. BOTTONE. Tenth thousand. London: Whittaker & Co., 2, White Hart Street, Paternoster Square.

The author of this book is to be congratulated on the large sale (for a work of the kind) which it has attained. No material alterations have been made since the first issue. Our comments when the work first appeared were not altogether of a favourable character, and we have seen no reason to modify what we then stated; if the public, for whom we presume the book is chiefly written, imagine they are gaining a clear insight into the subject of which the book treats by reading the same, then we are sorry for them; at the same time they may, perhaps, get their shilling's-worth.

## PAPER INSULATION.

MESSRS. FELTEN & GUILLEAUME have recently patented a form of lead covered cable with paper insulation, in which full advantage is taken of the low capacity that air insulation will give. The arrangement is peculiarly well adapted for forming a quadruple cable, *i.e.*, a cable in which four conductors are used. The arrangement is shown by the figure.

The four conductors $a$, $a^1$, $a^2$ and $a^3$ lie in the four corners of a paper strip folded to a star shape and twisted spirally; the whole is placed in a lead tube after being first lapped over with a layer of paper forming a paper tube.

## OBITUARY.

### MOSES G. FARMER.

BY the death of Moses G. Farmer, which has recently occurred, we lose one of the earliest pioneers in electrical work. He might, with little exaggeration, be termed the father of incandescent electric lighting in America. His name will probably be best remembered in this country as being identified with the Farmer-Wallace dynamo, which was first brought to London in January, 1878, by Mr. Henry Edmunds, and for which it may be fairly claimed that it was the first direct current high-tension arc-lighting machine that could run 6 to 12 arc lamps in series. Mr. Edmunds, in an interview with Farmer in 1879, referred to the question of running arc lamps in parallel. Farmer at once stated that there was no difficulty in doing so, provided "you had a dynamo capable of generating a sufficiently large current in 'Webers' (as they were then termed), with suitable tension, it being only necessary to take arc lamps similar to those then in use, and provide each with a suitable resistance, which will enable them to operate just as well in parallel as in series." This statement, made in 1877, is certainly very interesting.

His experiments in electric lighting go back as far as 1859. In a letter to a friend, which was published in an American paper, Farmer says: "Some few of the citizens of Salem will doubtless recollect a parlour at No. 11, Pearl Street, Salem, Mass., which was lighted every evening during the month of July, 1859, by the electric light, and this light was subdivided too! . . . . It was undoubtedly the first private dwelling house ever lighted by electricity. A galvanic battery of some three dozen six-gallon jars was placed in the cellar of the house, and it furnished the electric current, which was conveyed by suitable conducting wires to the mantelpiece of the parlour, where were located two electric lamps, one on each end of the mantelpiece. Either lamp could be lighted at pleasure, or both at once, by simply turning a little button to the right for a light, or to the left to extinguish it. . . . . Its use was discontinued at that time for the simple reason that the acids and zinc consumed in the battery made the light cost about four times as much as an equivalent amount of gas light."

How Farmer obtained these results may be gathered from the following. In the summer of 1858, while reading of the very interesting experiments of Prof. Draper on the heat and light evolved by a platinum wire which was traversed by an electric current, Farmer was struck by the rapid increase in the amount of light given out as the temperature of the wire approached the point of fusion, and it occurred to him that, if the temperature of the wire could be steadily maintained quite near the melting point, a useful light could be obtained from it. He was not long in devising a combination of electro-magnets, rheostats and batteries, that would give the desired result, and early in 1859 he put the idea into successful and practical execution, and they had the light in the house at Salem.

He entered upon protracted investigations on various substances, and on the conditions which governed the management of the current.

He was most strenuous in his advocacy of the use of electric light, and wrote many papers with the object of convincing the public of its advantages. The cost of electric light was a subject to which he gave great attention. His remarks on the comparative cost of gas and electricity are not without interest even to-day, and it must be remembered that these opinions were delivered nearly 30 years ago. In his own words: "Perhaps, on the average, 1 lb. of illuminating gas will give 75 candle lights per hour. One pound of illuminating gas possesses a sufficient store of energy to enable it to give out by combustion about 20,000 units of heat, or the equivalent of about 16,000,000 foot-pounds of work. This, if burned in an hour, would average about 250,000 units of work per minute, or about 3,500 foot-pounds per minute per candle light.

"A very large electric light, say 10,000 candles, does not consume more than 20 foot-pounds of energy per minute per candle light, and even a small electric light of 20 candles need not consume more than 200 foot-pounds per minute per candle-light. So it might not seem extravagant to expect that 1 lb. of gas per hour could be burned in a suitable furnace under a proper boiler, and steam be taken from the boiler to a steam engine to drive a magnetic electric machine, which should supply five electric lamps that would give more light than five gas lamps, each consuming one-fifth of a pound of illuminating gas per hour."

### SAMUEL ELKINS PHILLIPS.

We regret to have to announce the death of Mr. Samuel Elkins Phillips, F.C.S., who died at his residence at Reading, on the 23rd inst. The deceased gentleman was in his 80th year.

His first active connection with electricity was with the late Dr. Whitehouse, in the early days of the first Atlantic Cable project. He acted as Dr. Whitehouse's assistant for some years, and was hence connected with many of the early electrical problems which confronted the pioneers of Ocean telegraphy.

Later on he was appointed the superintendent of the Benghazi station on the telegraphic line connecting Malta and Alexandria *via* Tripoli and Benghazi.

Subsequently returning to England, he was appointed as one of the superintendents who went out with the Persian Gulf cable. During the term of his three years' agreement with the Government, he was for most of the time in charge of the Bushire station. Since his return from Persia he has not taken any active part in electrical matters, but has written occasional letters to the technical journals on electrical and chemical subjects.

The only work he ever published was a small volume on "Old or New Chemistry."

His kind and sympathetic nature made him much beloved and respected by all who knew him.

## NEW ENGINEERING AND ELECTRICAL LABORATORIES, UNIVERSITY COLLEGE, LONDON.

THE buildings forming the new engineering and electrical laboratories of University College were formally opened, on Monday last, by H.R.H. the Duke of Connaught in the presence of a distinguished gathering. The amount expended on the present extension is £20,000, of which about £14,000 represents the outlay on the engineering and electrical departments facing Gower Street. The present number of engineering students is about 80, and it is calculated that the extension will enable the institution to receive 150.

The northern half of the new block, which is to be used as the new engineering laboratory, has no basement, so as to afford solid foundation for the machinery to be placed in it. This space, the dimensions of which are 50 feet by 98 feet 3 inches, contains an engine room and an office, a calorimeter room, cement testing room, and a private room for the professor, besides the general laboratory.

The southern half of the new building forms the electrical department, and includes a dynamo room, a lecture theatre with an apparatus room adjoining, an electrical laboratory and a private room for the professor. The dynamo room is 31 feet by 22 feet, the floor of which rests on the solid ground, being formed of concrete 24 inches thick. On the level surface of this concrete is laid a series of teak beams, 6 inches deep by 4 inches wide, in section, and on these are sliding rails for the machines. For charging accumulators there is a Crompton shunt-wound dynamo of 10 horse-power, driven by a 9 H.P. nominal gas engine. The adjoining lecture room is 35 feet by 32 feet, with a tier of benches to accommodate about 80 students. Beneath this room is the accumulator room, 35 feet by 12 feet, built of white glazed brick, and will contain, on teak benches, a set of 52 eleven-plate Crompton-Howell batteries, which will discharge up to 100 ampères.

Beyond the lecture room, on the same level, is the electrical laboratory, 50 feet by 32 feet, at one end of which is a photometric gallery, 30 feet by 6 feet, and 10 feet high. Accommodation is afforded for a considerable number of students working at the same time. Beneath the laboratory is a commodious shop, where carpentering operations of all kinds are provided for. A part of the electrical laboratory is to be devoted to standardising and calibrating of instruments.

The whole arrangements have been most carefully designed, and the arrangements made for all kinds of testing and measurement are most complete, so that the efficiency of the various items of the plant are accurately indicated.

One important feature of the dynamo plant is a machine designed specially for testing and experimental purposes, consisting of four dynamos bolted on to the same bedplate, which is thus described by Prof. Fleming: "The four machines constitute two similar pairs. Each pair consists of a continuous current Kapp motor of 5 horse-power, which is coupled on the same shaft with a Kapp alternator of 5 horse-power. The combined motor-alternator is carried on two bearings, and has an outside pulley with a flange. The two exactly similar motor-alternator plants are bolted on to the bedplate, with their pulleys adjacent, and their shafts in one line. The pulleys are capable of being coupled together by a bolt through the flange, in such a way as to set the alternator armature bobbins in any relative positions."

It will be seen that the above-described combined plant is capable of a great number of uses for experimental purposes.

1. Either plant may be run separately by a belt from the countershaft, and will produce from the alternator an alternating current at 100 volts and 37 ampères, and from the continuous generator a continuous current of 100 volts and 37 ampères. The two alternators or two generators may be coupled in parallel, and give double the current of either at 100 volts.

2. By coupling the shafts rigidly together, they may be run as one plant, and either the currents or the potentials added together, so as to give one alternating current of 200 volts and 37 ampères, and one continuous current of 200 volts and 37 ampères.

3. Either of the continuous current machines can be driven as a motor by the current supplied from the secondary batteries, which are charged by the Crompton dynamo, and in this way alternating currents of various frequencies may be obtained from either plant, or from the two plants running as one.

4. The two separate plants can be so coupled together that the alternating currents furnished by each alternator separately are in any relative difference of phase. Thus they may be coupled so as to give two currents differing 90° in phase, and the effect of a two-phase alternator is produced by the combined plant.

5. By running one continuous current machine as a motor, and the other as a generator, the combined efficiency of the two continuous current machines may be obtained, or in the same way the combined efficiency of the two alternating current machines.

The whole of the new building is to be lighted by incandescent lamps, but provision is also made for lighting by gas. The electrical fittings are supplied by the Edison and Swan Company.

The new wing is intended to be ready for use by October.

## NOTES.

**Cable Communication.**—The following are the interruptions which have occurred, and the repairs which have been effected during the week ended 30th inst.: Assab-Massaouah cable repaired May 25th, 1893; St. Thomé-Loanda cable interrupted May 30th, 1893.

**South African Library Electric Lighting.**—The South African Public Library at Cape Town is now lighted by electricity.

**An Electric Organ.**—An electric organ, on the Hope-Jones system, has been erected in the church of St. John, Penymynydd, near Mold. The organ was presented by a lady attending the church.

**The Failure of Condenser Tubes.**—In a report on the failure of the U.S. warship *Baltimore's* condenser tubes, Engineer Hunt calls attention to the serious danger from galvanic action in such tubes. When through accident or wear the tin coating has been removed at any point, a brass surface is left exposed, adjacent to and intimately connected with a tin (tin-lead alloy) surface, and this is covered by an exciting liquid, namely, sea water. That under such circumstances galvanic action would take place cannot be wondered at, and one element or the other of the local battery thus formed would undoubtedly be attacked. To prove the existence of a current in a couple similar to this, Engineer Hunt immersed two sections of condenser tubing, from one of which the tin coating had been removed, in salt water, and found a very perceptible current, using a galvanometer that was not at all sensitive. Zinc, a constituent of brass, is the most electro-positive of all the common metals, and would in such a couple be the metal destroyed, and that it was destroyed was shown by an analysis of the altered tubing. The most remarkable result of the investigation was the observation that the spongy copper left after the zinc had been destroyed by the galvanic action absorbed nearly 3 per cent. of water by weight, and nearly 25 per cent. by volume, showing that the alloy used for the tubes (Cu 60, Zn 39, Pb 0·25) was not a suitable one.

**The Smoke Nuisance.**—In a recent discussion on town smoke which took place at a meeting of the Manchester section of the Society of Chemical Industry, there were some strong expressions of opinion made which should prove specially instructive to the gas companies. Dr. Bowman thought it was quite possible that cheaper gas might be produced, which would encourage its consumption as a fuel, thus diminishing the use of coal gas. The introduction of the electric light was rendering the illuminating power of gas not so essential, and in course of time, he said, "people would look back upon the present system as a very barbarous one." Dr. Bailey felt that in an increased supply and use of gas as a fuel would be found the solution of the problem of how to purify the atmosphere of our large towns. He referred to the immense amount of sulphur left in the gas by the companies, which is such as to render the air of rooms when much gas was used as an illuminant absolutely intolerable. He welcomed the fact that they were within reasonable distance of an extended application of the electric light, and thought it would herald an immense relief from fog and the depressing condition of the atmosphere, which now prevailed in and around Manchester. Other speakers expressed themselves in much the same strain.

**Indignant Gas Consumers.**—The increasing use of electric lighting, and the continual downward tendency of the price per Board of Trade unit charged by supply companies, are making themselves felt throughout the country. The recent talk of St. Mary's Vestry, as to the intention of taking up the supply themselves, is, no doubt, the cause of a recent meeting of the gas-consuming public of that neighbourhood in a hall in Banner Street, at which Mr. James Rowlands, M.P., presided. The ostensible reason was to protest against "the exorbitant price charged for gas by the Gas Light and Coke Company." We are afraid that individuals, and even local authorities, protest in vain, unless steps are taken to carry the war into the enemy's camp in a spirited manner. The price of gas depends upon what the large gas corporations find they can obtain for it, for with such a monopoly it is hardly to be expected that a golden harvest will not be reaped while the opportunity exists.

**Who is Pinkus?**—A certain Mr. Pinkus, who flourished in the year 1840, is credited by Mr. Preece with the original conception of electric power transmission. To which, in reply, Mr. Gèraldy—the eminent French electrician, whose recent death we have had to deplore—asserts that the first trial of an electric motor was made by Jacobi, in 1839, on the Neva, and that his experiment was followed by 33 years of inactivity in electric power transmission. Everyone now asks, "Who is Mr. Pinkus?" *La Lumiere Electrique*, for April 15th, passed the question across the Atlantic; and now, from America, our namesake sends it back to us: "Who, who, is Pinkus?" This same article in the *Electrical Review* of New York gives, in addition, a *résumé* of Mr. Gèraldy's opinions with regard to international courtesy, levelled chiefly at our British representative. While we are sorry that the world should have occasion to pink us on the score of courtesy, we can suggest to them no redress beyond our heartfelt sympathy. But the "Pinkus" mystery may be completely solved by reference to our pages of January 8th, 15th, and 22nd, of last year, in which numbers "The Inventions of Henry Pinkus, of Pennsylvania," are exhaustively dealt with. Mr. Preece evidently reads the ELECTRICAL REVIEW of London to some purpose.

**Electric Heating.**—Although electric heating and cooking appliances cannot be held to rank as engineering details, their use is so closely allied to the other advantages which are derived from an electric supply, that even technical journals may condescend to give them a place with more important things. In our last issue we mentioned what had been done in this line recently, and curiously enough gave utterance to very similar statements to those contained in a letter which appears in our issue of to-day, from the pen of the well known gas engineer, Mr. Thomas Fletcher, F.C.S., of Warrington. It is a pity that the makers of such appliances do not grasp the fact that at the lowest present rates it is only possible to obtain 1,000 British thermal units for every penny paid for electricity, and that operations in heating and cooking are merely practical experiments in electro-calorimetry on a rough scale. We are pleased to note that Mr. Fletcher is at one with us as to the ratio between the cost of gas and electric heating where water is the recipient of the evolved heat. This ratio we stated to be as ten to one, and figures are given by that gentleman which prove that 600 B.T.U. can be utilised out of a total thermic energy of 660 B.T.U. per cubic foot of gas, or say, approximately, 90 per cent., or that which has been the best result from electric heaters. A modern gas water heater is internally flued, and the temperature of the waste gases is comparatively low, so that one would look for practically as good results as can be obtained from resistance wires lying against the bottom of vessels containing the liquid. While this is so there are, as we pointed out, many people to whom electric kettles and such like novelties would be a boon, and in addition it must be remembered that remarks as to cost of water heating do not apply with anything like the same force to other operations, where the specific heat of the object of attention is considerably under unity. In the aggregate such appliances may befriend central station supply, although individually they are but as the fabled mouse to the lion—in this case the supply for lighting purposes.

**Au and Pt E.M.Fs.**—The text-books put gold before platinum in Volta's electropositive series, which leads to the expectation of a greater evolution of heat when gold combines (say) with chlorine, than when platinum does so. This, however, Prof. E. F. Herroun considers to be not the case. Julius Thomsen gives for the heat of formation of platinic chloride a value considerably greater than that for auric chloride. Gold, therefore, Prof. Herroun concludes to be electro-negative to platinum.

**Doctors and Telephones.**—A large and somewhat warm indignation meeting of Sheffield doctors was held a few days ago, protesting most strongly against the action of the National Telephone Company in removing the telephone from the premises of one of themselves, who was evidently of high standing amongst the medical profession in that part of the country, and was, therefore, much in demand upon the telephone. The facts of the case are these: Dr Dyson formerly had an agreement with the Sheffield Telephone Exchange Company, whose business rights were purchased by the National Telephone Company, to whom that agreement was accordingly transferred. Last August, the company sent Dr. Dyson notification to terminate the existing agreement for the purpose of arranging a more modified one; but there being, as he stated, several items in the agreement with which he could not comply, he declined to sign it. The company were, of course, fully entitled to act as they considered best for themselves in the matter by cutting off communication, although that course seems to have been resorted to rather hastily. The doctors of Sheffield were much inconvenienced and annoyed, and the company have been considerate enough to replace the telephone pending the signing of the agreement. The upshot of the doctors' assembly was the formation of a committee to consider the agreement, and report to a future meeting of the profession. We cannot help thinking that Dr. Dyson might have prevented a great deal of trouble and annoyance had he considered and discussed the question of the new agreement with his medical friends more than six months' ago, when it was first submitted to him for signature.

**Liverpool Library Electric Lighting.**—The Liverpool Library, Bold Street, has been lighted by electricity, at a cost of £82. The Committee believe that this expense will, in a few years, be more than recouped by the saving in book-binding alone.

**The Lamp Situation in America.**—The Westinghouse Company has, within the last few days, submitted its report to the shareholders in that concern, and in no hesitating or uncertain voice expresses the belief that, despite the gigantic efforts made by its rivals to crush its incandescent lamp business, the new stopper lamp has—to use a phrase of local origin—come to stay. The Alleghany works are at present equipped for an output of 5,000 lamps per diem, and extensions are now in hand which will enable this capacity to be quadrupled. Certainly the use of these lamps exclusively for incandescent lighting at the World's Fair should form an important experience, both to the makers and the profession generally; for with the publicity to which they will be subjected, and the keen criticism with which any troubles or defects will be received, we, on this side, will be enabled to form a judgment which will be near to the truth, but for which, under less favourable circumstances, it would have been difficult to obtain the necessary facts. The low cost of the lamps meet expectations fairly well. At present fifteen pence is charged for the sizes upon which there will be the greatest run, and of this one-third or fivepence is returned upon the makers receiving the globe and stopper in good condition after the destruction of the filament. To central stations a discount of 10 per cent. is allowed, and an efficiency of 2½ watts per candle-power average during life is claimed. On this latter point we have heard nothing; presumably, the term of existence will be found to be less than what we usually associate with the better known makes; but one can well afford to lose something on this score, when the initial cost is so materially reduced. The latest phase of the lamp question, indeed, looks as if the statement that "a temporary check has been turned into a great business advantage" bids fair to be realised.

**The Electric Tramway in its Social Bearing.**—It does not seem unlikely that the electric tramway will be the means of revolutionising domestic life in our Colonies, and of considerably modifying several of the more general classes of business. Toronto, Canada, has to-day 27 miles of shop fronts, but the tendency is for many of the smaller shops on principal thoroughfares, such as King and Yonge Streets, to revert to residential purposes, they having found their occupation gone. The principal cause at work tending to bring about this change is the partial solution of the rapid transit problem by electric tramways. By such means the residents in the outlying districts of the city can be transported to the business centre in a few minutes. The larger down town establishments are benefitting by this to the detriment of the smaller concerns on the less important streets in the suburbs. The lesser influence is that of the "store," in which the businesses of almost every class is congregated, and where comfort is assisted by electric lighting, electric lifts, and general sumptuousness. These changes are most seriously affecting the value of a large amount of property now used for business purposes, and it may not be long before similar conditions impress themselves upon our communities at home.

**Repairs to Submarine Cables.**—Mr. F. A. Hamilton, in an original communication to the *Journal of the Institution of Electrical Engineers*, gives the results of an extended experience of Trott and Kingsford's automatic grapnel for submarine cables and torpedo lines. This grapnel contains an insulated wire—a continuation of the heart of the grapnel rope—connected to an insulated metal disc, recessed in the crown of the grapnel. Pushes, which in their normal position are caused to project, by means of spiral springs of any desired strength, are inserted between the shank and prongs. These pushes are fitted with fine steel points, which, when driven in by pressure being applied to the head of the push, make contact with the metal disc, and consequently bring into action the battery and bell connected with the conductor contained in the grapnel. For ordinary work the springs respond to about 90 lbs.; but when the cable is much deteriorated weaker springs are used, in some cases responding to only 20 lbs. Mr. Hamilton advises that in paying-out the grapnel rope for the first time, on no account should a "jockey" be used. The "jockey," he says, has the effect of bulging the outer layer. The rope will adjust itself after clearing the drum and sheaves, and the oftener it is used the kinder it becomes. Every cable engineer knows how hard it is to determine just when the line is hooked. Dynamometer readings are by no means dependable, and the device of sitting on the grapnel rope is a little *infra dignitatem*. We advise all engineers to accept the hints of Mr. Hamilton, and give the grapnel a trial.

**Engineering Colleges in America.**—Technical colleges in America are going forward at a great rate, and are likely to afford a little amiable competition with similar institutions throughout the world. The new Engineering and Experimental Physics Buildings of the McGill University have been recently opened, and there seems to be every indication that it will be a great success. The machinery and instruments are, apparently, all that could be desired—engines, dynamos and switchboards, voltmeters, ammeters, galvanometers, are lavished upon the fortunate students, while the building itself seems eminently suited to the purpose for which it is intended. At the same time the Stevens Institute of Technology has risen as a school, of which our Finsbury Technical College is a prototype; and like the Finsbury College, it is, to more than overflowing, full. Proposals seem to be on foot for applying for Government aid to help the Stevens Institute to extend its usefulness. We can only hope that enough work will afterwards be found to satisfy the needs of all these fledglings, both in England and America. There is no doubt that they are all able to make a start in life from such institutions; in some works or other there will be found a corner for them; but progress afterwards is, in most cases, an up-hill journey, and it is to be feared that only a few will reach the top. Townships are adopting the trick of running their lamps without an appointed electrical engineer; if this goes on, a stoker, a jointer, and a linesman will soon be the only staff employed. What then will all these students find to do?

**The London-Paris Telephone System.**—The engineer-in-chief's staff at the General Post Office, acting in conjunction with the officers of the French Telegraphic Administration, have been engaged during the past month upon a very interesting series of experiments to determine the practicability of using the London-Paris telephone wires simultaneously for telephone and telegraph messages. The Van Rysselberghe system has been tried, together with others, having for their object the attainment of the same result. The conclusions arrived at are not yet known, but it is probable that upon at least one of the two London-Paris telephone circuits a practical trial of simultaneous telegraphy and telephony under ordinary working conditions will be made.

**Electrolysis of Water Pipes.**—In a paper read before the New England Water Works Association, by C. H. Morse, Inspector of Wires, Cambridge, Mass., the effects of electrical tramway currents upon water pipes are described. It was found that lead pipes had disappeared in a short space of time, some even in six or eight weeks. Iron pipes had been tried with the same result, also galvanised iron; brass pipe had been put in and deterioration was noticed at once. Rustless iron was tried, and it did rust decidedly. Observations were made by several of the water works *employés* unintentionally. Such an immense amount of current was flowing over the pipes that, upon attempting to make a joint by putting oakum around the pipe, it was found that the electric arc was sufficient to set fire to the oakum.

**Zinc and Chlorine by Electrolysis.**—The metallurgy of zinc has offered a good field for the application of electrolysis, and has been the subject of several inventions, which have had for their object the extraction of the metal from its ores. In these days, however, where, as experience has shown, the bye-products of an operation may be as valuable as the main product of such operation, inventive activity is directed to the evolution of methods whereby the bye-products shall not be waste-products, as used to be the case; but substances having properties so valuable and so well recognised that the economy of production thus perfected. As an illustration of this tendency, we notice a new process of preparing zinc by wet electrolysis from the ores with the incidental production of chlorine, which is so highly esteemed as a chemical agent. Sulphide of zinc, or zinc blende, is roasted together with an alkali or alkaline earth, with the result that chloride of zinc, and the sulphate of the alkali or alkaline earth are produced. These salts are then made into a cold, saturated solution, which ought to contain them in molecular proportions, and the solution is electrolysed with the production of zinc and chlorine. Zinc cathodes and carbon, or chromium phosphide anodes, answer well, and 10 amperes per square foot of anode surface is a suitable current density.

**Proper Use of Terms.**—The last issue of the *Electrical World* contained the following leaderette:—"An English contemporary in a supplement defines the Board of Trade unit as one thousand watts for one hour, and but a few lines above says that a unit is a thousand watts. It seems to us that this term is used in a very loose sense, although, of course, a confusion need not necessarily arise in the mind of an electrical engineer, who will understand from the context what is meant. If a 'unit' is 'a thousand watts for one hour,' it is not suitable for measuring the quantity of electrical energy registered by an ordinary consumer's meter, in which one unit may just as well have been a thousand watts for one hour as one watt for a thousand hours, or any other product of hours and watts amounting to one thousand. Judging from the methods of charging used in England, namely, a fixed price per unit, both the definitions given in that paper are incorrect, as a unit is, in that case, neither a thousand watts nor a thousand watts for one hour, but it is simply a thousand watt-hours without any further qualification. One horse-power-hour may be intended to mean 1 horse-power for one hour as distinguished from 2 horse-power for half an hour, but from the way in which electrical energy is sold in England, there appears to be no such qualification in the definition of the Board of Trade unit. Careful writers will do well to express themselves more clearly in using this term."

**Electric Cranes.**—Quite recently the directors of the Union Warehouse Company have fitted up the whole of their buildings between Manchester Road and Union Street, Bradford, with cranes to be worked by electricity from the Corporation mains. Hitherto the cranes have been worked by hydraulic power, but the severe frosts of the past two or three winters have proved most destructive to the plant. Mr. Joseph Clark, of Laisterdyke, has supplied the cranes, and Messrs. Crompton and Company, Limited, the motors, twenty in number.

**British Exhibits at Chicago.**—The Postal Telegraphic Department's exhibit for the Chicago Exhibition left London in the ss. *Europe* for the United States early last month. It has doubtless reached its destination by this time. It is a repetition of the exhibit that attracted so much attention at the Crystal Palace Exhibition last year, and comprises in all 178 items. Of these 142 are samples of historical apparatus and plant now out of use; and the remainder are specimens of the apparatus now employed. Much of the latter will be exhibited in full work at Chicago. Mr. John Chapman, one of the engineers attached to the engineer-in-chief's office, left Liverpool on Wednesday in the *Majestic* for New York, *en route* to Chicago, to fit up and take charge of the exhibit during the course of the Exhibition.

**A Metallic Diaphragm in Electrolysis.**—The term diaphragm is somewhat oddly, though still correctly, used when it is applied to a thin layer of mercury. Kellner, says *Industries*, has recently introduced a thin layer of mercury to separate the anode and cathode chambers in the electrolytic production of caustic soda. Sodium is deposited into the mercury on one side, and is dissolved out on the other, the result being that the caustic is produced free from chloride. Any hypochlorites in the anode chamber cannot attack the mercury, because the surface exposed to them is a cathode surface. The anode side of the mercury cannot be corroded, as it is in contact with caustic alkali, so the sodium is dissolved out instead. We believe Mr. Vautin, of Commercial Road, London, E., has also been working on these lines.

**The E.M.F. of Galvanic Combinations.**—There is a long paper in the *Zeitschrift für Physikalische Chemie*, by W. Hittorf, which is chiefly remarkable for the great accumulation of experimental results which it contains [*vide* x., pages 593—620]. Amongst these we note that ammonium nitride is decomposed in an aqueous solution by the electric current, with the result that nitrogen gas is given off at the anode, whilst hydrogen is evolved at the cathode; the proportions are three volumes to one respectively. Although ammonium nitride decomposes into its elementary constituents, under the action of the current, with a considerable evolution of heat, this substance is found to need an electromotive force of more than one volt in order to effect the electrolytic decomposition. This investigation involved an examination of various liquid galvanic elements with regard to their electromotive forces and the relation which exists between these and the thermo-chemical data of the reactions taking place in these elements.

**Personal.**—Mr. Cawley, who has been chief editor of *Industries* since our contemporary was started some seven years ago, is about to retire, but not before gaining for *Industries* an established position in the field of technical journalism. At the beginning of this year a change occurred in the proprietary of our contemporary, and this, we understand, led to Mr. Cawley tendering his resignation. After concluding his editorial work, he intends carrying on business as consulting engineer, and has taken offices at 29, Great George Street, Westminster, S.W. We are glad to learn that Messrs. Swinburne and Rideal will retain their respective posts on the staff.

Mr. B. Arkell, who was appointed electrician to the Peninsular and Oriental Company's steamship *Shannon*, which sailed for India on May 18th, qualified himself for the post at the electrical and general engineering works of Captain Ronald A. Scott, M.R.I., M.I.E.E., Acton Hill, W. This is the fifth appointment given by the P. & O. Company to members of Captain Scott's works, whilst others have been accepted and placed on the list for future vacancies.

**Melbourne Electric Lighting.**—The central station is nearing completion, and it is expected that in July the light will be turned on.

**Thermo-Electrics: Electrolytes.**—A few months ago we noticed a paper by Mons. H. Bagard in the *Comptes Rendus* (cxiv., p. 980), in which were described some thermo-electric phenomena at the contact of two electrolytes. Couples, consisting of dilute sulphuric acid and a solution of zinc sulphate, and dilute sulphuric acid and cupric sulphate solution were placed under examination, when variations with the temperature, similar to those observed with a couple formed by an amalgam and an electrolyte were observed. In the case of the zinc sulphate, the electromotive force was found to increase at first with the temperature, to attain a maximum, and then decrease, whilst in the case of the copper sulphates, the electromotive force increased, reached a maximum at 40° C.; then at 70° became *nil*, and afterwards again increased. Since these experiments, Mons. Bagard has been investigating the behaviour of couples formed by two solutions of zinc sulphate of different concentrations. For a given temperature he finds (*vide Comptes Rendus*, cxvi., p. 27) that the electromotive force is greater the greater the difference between the degrees of concentration of the two solutions, and that the neutral point is higher the greater the difference of concentration. On examining his results, he finds that the "law of intermediate substances," and the "law of intermediate temperatures" both hold good.

**The Bordenane Conduit.**—The Bordenane system of constructing pipes, retainers, conduits, and other underground works by sidero-cementation seems to possess some novel features. The general principle consists in embedding a framework of iron bars in cement mortar. Bars of channel section are used, wound in helices, the pitch of the spiral being suited to the section of iron employed, and the pressure to which the structure will be subjected. The structural strength is given by the metallic framework. The working stress is allowed to reach 9 to 10 tons per square inch. An experimental line of four miles is in use, and the expansion of iron and of the cement has been found to be practically the same. Several claims are made for the system of manufacture, and the absence of joints, with the durability of the materials, should bring the system into use. For conduits of large size, or subways, such a method of construction might be found to reduce the present excessive cost, and so increase the facilities for underground cable-laying which are at present in our large towns sadly deficient.

**Trial of Storage Battery Apparatus in New York.**—In New York, on April 21st, was made the first public exhibition of the street railway storage battery apparatus of the Waddell-Entz Company. *Electricity* (N.Y.), in commenting upon the tests, says the inventor's claims were fully borne out on that occasion. No brake was used; there was simply a reversal of the motor. The cars can be brought to a standstill within the length of the car from a speed of 14 miles an hour. In this sudden stopping there is no waste of power. On the contrary, the momentum converts the motor into a dynamo, and there is a positive storing up of energy. The cars can be run backward as well as forward. The cars can run 30 miles without recharging the batteries. The batteries themselves weigh but 2,000 lbs. each, two being placed on each car. The electric plant which has just been completed at 127th Street and Second Avenue consists of two 100-horse-power safety boilers, two automatic engines of 75 horse-power, and two 75-horse-power dynamos. From the dynamos the current is led by switch-boards on the battery floors. On the second floor is a large electric crane. By a touch two batteries, weighing 4,000 lbs., are lifted and then lowered to the first floor, where they are transferred to the cars. The old batteries can be removed and newly-charged ones put in the cars within two minutes. The system is the invention of the Waddell-Entz Electric Company, and the entire plant, including dynamos, motors, &c., was made at their works at Bridgeport, Conn. It is expected that by June 1st the Second Avenue line from Ninty-sixth Street North will be exclusively operated by electric cars, and a little later the system will be adopted for the entire line.

**African Telegraphs.**—A telegraph office has been opened at Wydah, in the French colony of Benin.

**Aberdeen Electric Lighting.**—An electrical engineer is to be appointed by the Town Council. The salary is to be £200 per annum.

**The Netherlands Telegraph Department.**—M. J. P. Havelaar has been appointed Director-General in the place of M. Hofstede, recently deceased.

**Damage by Lightning.**—Lightning, during the recent stormy weather, appears to have done much damage in various parts of the country. The cases are too numerous for us to mention them in detail.

**Obituary.**—The death is announced of Mr. A. W. Meston, the inventor of the "Meston" motor, regarding which we had a note in our last issue.

**Middlesborough Overhead Wires.**—Referring to our recent note on the subject, we understand that the Corporation have now decided not to allow electric wires to be carried overhead.

**Worcester Workhouse Electric Lighting.**—The Board of Guardians have decided to invite tenders from three different companies for the supply of the electric light fittings at the workhouse.

**Norwich Electric Lighting.**—A petition against the Corporation borrowing £15,000 for electric lighting purposes is being signed by Norwich ratepayers, and is to be presented to the Local Government Board Inspector when he holds the usual enquiry.

**New Cable.**—The West Coast of America Company notify that a new cable will shortly be laid between Valparaiso and Talcahuano, for which an overland line has already been constructed between Talcahuano and Concepcion. The cable will be 277 knots long, and the overland line 12½ miles.

**The Royal Society.**—The following paper was down for reading before this Society yesterday afternoon :—"Note on the Flow in Electric Circuits of Measurable Inductance and Capacity; and in the Dissipation of Energy in such Circuits," by A. W. Porter.

**Private Bills in Parliament.**—The Bill of the Brighton and Hove Electric Light Company has been withdrawn from Parliament. Among the Bills which have passed the Standing Orders of the House of Lords are those providing for the electric lighting of Hackney, Hammersmith, Poplar, Islington, and Reading by the local authorities.

**Earth Currents.**—As the result of six months' observations on the Java-Australian cables, Mr. J. K. Gibson finds that an alternation of the earth current takes place for 13 hours, and that during the night the current is very weak. No relation between the currents and the tidal motions seems to exist. On the Atlantic cables there are two alternations every 24 hours.

**Electric Light Main Boxes.**—A *Times* correspondent calls attention to what he calls a source of danger in many streets, owing to the non-ventilation of the "boxes" of the electrical companies. He refers to a main box in Brook Street, W., belonging to the Westminster Electrical Supply Corporation, the composition of the cover of which was blown out of its socket on the night of the 25th inst.

**Ocean Telegraphy.**—A Reuter's telegram in Wednesday's *Daily Telegraph* reads as follows :—"A telegram has been received at New York from Chorillos, in Peru, stating that the laying of the duplicate cable of the Central and South American Telegraph Company was completed on Monday. The new cable is 2,524 miles in length, and extends from Salina Cruz, in Mexico, to Chorillos, a port near Lima. It was manufactured in London, and has been laid within ten months, an accomplishment which eclipses all previous operations in the laying of submarine cables."

**Waterloo and City Electric Railway.**—The City Commissioners of Sewers intend petitioning Parliament against an alteration in this railway Bill.

**Wolverhampton Electric Lighting.**—Mr. F. Harman Lewis, electrical engineer to the Hull Corporation, has been appointed to a like position under the Wolverhampton Corporation, at a salary of £300 per annum. Congratulations.

**International Maritime Congress.**—The second meeting of the International Maritime Congress is to be held in the rooms of the Institution of Civil Engineers, 25, Great George Street, Westminster, on July 18th, 19th, 20th and 21st. Among the various subjects to come before the meeting we notice the following :—"Lighthouses, and their Illumination; Electrical Connection of Lighthouses and Lightships with the Shore; Fog Signals."

**Southport Electric Lighting.**—Originally the council decided upon an extensive scheme, costing about £40,000, but the committee having the matter in hand recommended a much smaller scheme, the installation only to cover the principal streets and a part of the promenade. This change of policy caused much trouble and lengthy heated discussion at last Tuesday's meeting of the Town Council. The committee carried their resolution for the lesser scheme by a very small majority.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Bishop's Stortford,** June 17th.
**Grimsby** „ 9th.
**Norwich** „ 10th.

The local authorities of these three districts are inviting tenders for the public lighting for one year. No special system of illumination is stated.

**Cardiff.**—June 19th. The corporation are prepared to receive tenders for the construction, supply, and delivery of boilers, engines, machinery, and electrical apparatus. Plans may be seen on application to Mr. Wm. Harpin, borough engineer, Cardiff; or to Mr. Wm. H. Massey, 25, Queen Anne's Gate, Westminster.

**Halifax.**—July 1st. Tenders for the supply and laying of a system of underground mains, &c., &c. Full particulars will be found among our advertisements.

**Portsmouth.**—June 23rd. Supply and erection of electric light cables, conduits, feeding boxes, &c. See our advertisement pages for further particulars.

**York.**—June 6th. For the following articles during six months ending December 31st, delivered carriage paid at the telegraph stores at York, for the North-Eastern Railway Company: 1. Telegraph apparatus. 2. Telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the Secretary at York, sealed and marked "Tender for Telegraph Stores," by noon on June 6th.

### CLOSED.

**Huddersfield.**—Tenders have been accepted by the Borough Council from Mr. Alfred Sykes, of Turnbridge, for the supply and fixing of the electric lighting fittings at the electric light station in St. Andrew's Road; Messrs. Calvert & Co., for the supply and fixing of the cast-iron exhaust pipes required for the boilers at the station; and Messrs. Liversedge & Co., for the supply and fixing of a lightning conductor for the chimney at the station.

## BUSINESS NOTICES, &c.

**J. A. Berly's Universal Electrical Directory** for 1893 (12th year), is now ready, 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

**Gülcher Electric Light & Power Company, Limited.** The *London Gazette* contains notification of a general meeting of the members of the above company to be held on June 30th, at 2.30 p.m., at the offices of Messrs. Trinder and Capron, 47, Cornhill, E.C., for the purpose of having an account laid before them of the winding up, and other incidental business. This notice does not relate to the Gülcher (New) Electric Light and Power Company.

**Removal Notice.**—The offices of the United Electric Light Company are now situated at 5, Featherstone Buildings, Holborn, W.C.

**Catalogues.**—The General Electric Company, Limited, have this week brought out a new edition of their catalogues, well bound in one volume with red cloth cover. The book contains 400 pages 4to, about 10,000 illustrations, as well as numerous detailed prices and descriptions of the firm's manufactures, and much in the way of useful data and estimates. The following are a few of the noticeable features, some of which will serve as very complete, useful, and reliable guides to the student and professional man, as well as to electrical contractors and manufacturers. The amateur would feel quite at home in reading some of these instructions:—Comparative estimates of electric light and gas; Few notes upon the applications of electricity; Hints and estimates for wiring houses, warehouses, mills, &c.; diagrams are given which add largely to the interest of the remarks on this subject; Instructions for making joints in electric light cables, also some special points on cables and wires for the consideration of customers. Estimates for complete electric lighting plants; Instructions for fixing and connecting electric bells; Electric communication between lifts; Estimates of material required for erecting and fitting entire telephone installations; Remarks as to the use of accumulators or secondary batteries. Two pages of matter are contributed by Mr. W. C. Mountain, in which he gives instructions how to work a dynamo. The "General," "Shallenberger," and "Dr. Aron's" electricity meters are rather fully described, and space is devoted to arc lamps, electro-medical supplies, and electric light fittings, fixtures, and shades are likewise very extensively dealt with. Electrical glass ware is also a very noticeable feature, and illustrations are given of many neat and artistic specimens of shades and pendants. This portion of the volume, called the "Fixture and Glass Ware" catalogue, contains over 100 densely illustrated pages of electroliers, brackets, and many accessories, all of the cuts being drawn uniformly to scale. The "Plant" section begins with dynamos, steam engines, boilers, and central station appliances, then touches upon private plant details, such as gas and oil engines, accumulators, shafting, &c. The "Wiremen's Sundries" section describes in a number of pages, switches, cut-outs, lamps, wall plugs, cables, casing, insulating material, and the thousand and one articles which make up the requirements of a contractor of house wiring from central or private lighting stations. The catalogue opens with a page of definitions of electrical terms; further on appears a full-page illustration of a view at one of the English central stations. All the blocks are in one style, and are very neatly executed; the whole of the parts of the articles shown are standardised, and the sizes are given where any ambiguity might exist, while the majority of the views of fittings, &c., are scaled. On one point we must commend the practice which this company have initiated, and that is the use of ½-inch tube for electroliers and fittings. Brass-finishers' wiring has become a term of reproach, and the small size of ⅜-inch tubing so often used is altogether insufficient to allow two properly covered wires to be drawn through, whereas the difference in appearance is but little, and the larger size more than counterbalances the additional cost in the greater security and increased permanency of the fitting. The catalogue seems to be more complete than any yet published, specifications of the construction and uses of almost every one of the manufactures priced in it being given. The printing has been cleanly done, and, on the whole, Messrs. Binswanger are to be congratulated for bringing out such a capital catalogue, which we have no hesitation in recommending to the attention of the trade, as it forms in itself a text-book *par excellence*, and a valuable current price list of all that appertains to the calling of the electrical engineer.

The Edison & Swan United Electric Light Company have lately brought out another catalogue. It is known as Section V., and deals with various patterns of brackets, standards, electroliers, and fancy shades. Some of the designs described are very artistic. The illustrations, printing, &c., are all very well executed.

**New Issue.**—The Eastern Telegraph Company, Limited, offers for subscription, at par, £200,000 of four per cent. mortgage debentures (Mauritius subsidy) of £25 each of the Eastern and South African Telegraph Company, Limited, being part of the total of £300,000 to be secured by a first charge upon the subsidies, amounting to £28,000 per annum, granted by Her Majesty's Government for a period of 20 years, in respect of the Zanzibar-Seychelles-Mauritius cables, and upon the net receipts of such cables. The proceeds of this issue will be applied in part payment for the manufacture and laying of about 2,310 miles of submarine telegraph cable, which are about to be laid for the South African Company to connect the existing lines from Europe along the East and West Coast of Africa at Zanzibar with the Island of Seychelles, and thence to the Island of Mauritius. The subscription list will close on or before 4 o'clock on Wednesday next.

**Dynamo Forgings.**—Messrs. Harold & Jenkins have at present a large number of orders in hand for armature discs, transformer stampings and magnet forgings. It is, however, noticeable that the attempts of English manufacturers to standardise their various designs are few and far between, and the stampings or forgings are seldom ordered twice of the same dimensions. Americans are more active in this direction, and carry out the system of making a large number of machines to a given standard very extensively. Messrs. Harold & Jenkins state that their American orders are therefore for large quantities of one size of stamping, but this is probably partially accounted for by the English customers being nearer to the source of supply. There would doubtless be a considerable saving effected in the price of material, such as stampings and forgings, if fewer sizes in larger quantities were ordered.

**Huddersfield Electric Lighting.**—Mr. J. A. Crowther, of Lockwood, has been appointed mechanical engineer in connection with the electric lighting department at Huddersfield.

**Electric Pumping Plant.**—The Shilbottle Colliery Company, of Lesbury, Northumberland, have placed a contract with Messrs. Ernest Scott & Mountain, Limited, for an electrical pumping plant for their colliery. The installation will consist of compound wound Tyne dynamo constructed to give an output of 25,000 watts at an E.M.F. of 500 volts; the main switchboard, with measuring instruments, between 1,200 and 1,300 yards of concentric lead covered and protected cable, and a set of three-throw pumps with 25-horse power motor, the pumps to deliver 200 gallons of water per minute against a head of 185 feet. Messrs. Scott & Mountain have also secured a contract for a firm of coalmasters in Scotland for a complete coal-cutting plant. The coalcutter will be fitted with discs and is to cut 3 feet 6 inches deep, and will be driven by an 18-horse power motor. The generating plant is being put down sufficient size to run three coalcutters.

**New Partnership.**—We understand that Mr. Walter Phillips, M.I.N.A., M.I.Mech.E., consulting engineer and naval architect, has opened a branch of his business in Southampton, and has taken Mr. John R. Cowell, A.M.I.Mech.E., into partnership to manage and represent him there. Mr. Cowell has an intimate knowledge of his profession, and we think that Southampton is a district where his abilities will be recognised. The address of the firm is 32, Queen's Terrace.

**Hull Electric Lighting—Extension.**—The Electric Lighting Committee recommend the acceptance of the tender of Messrs. Callender & Co. for laying the mains in the extended area at the price of £1 19s. 6½d. per yard. The Bank of England premises at Hull are to be supplied with 53 16-C.P. lamps and 77 8-C.P. lamps.

**Electric Lighting of College Premises.**—Mr. T. Harding Churton, of South Parade, Leeds, has secured the contract for the lighting of the new buildings, now in course of erection, for the medical department of the Yorkshire College at Leeds. About 750 incandescent lamps will be used.

**Electric Lighting at Rugby.**—A boarding house that is being erected at Rugby is to be lighted throughout by electricity. There will be 100 16-C.P. and 50 8-C.P. incandescent lamps. The consulting electrician for the work is Mr. MacMullan, of London.

## CITY NOTES.

### Elmore's American and Canadian Patent Copper Depositing Company, Limited.

THE directors' report for the period commencing with the date of incorporation on January 26th, 1892, to March 31st last, reads as follows:—

"As explained in the circular of October 31st last, the board, acting on the advice of our American agents and upon their own judgment, decided to defer incurring expenditure of capital in demonstrating the Elmore process in America, inasmuch as the intending purchasers of our rights were already perfectly satisfied with the excellence of the various consignments of samples which this company had submitted to them, and stated that no mere trial plant, however successful, would suffice to settle the question of the commercial practicability of the process on a large scale, and that in this respect they could only be satisfied by being allowed to see the established and continuous results of the working of the Elmore companies in Europe. Contrary to all reasonable expectation, and owing to want of adequate working capital, the European companies did not, in 1892, make that progress which was anticipated, and consequently our negotiations for the sale of our property have been much delayed. However, in view of the recent investigations and reports made by select committees of the shareholders of the English and French companies, it is evident to the board, and is daily becoming more and more apparent to the public, that, notwithstanding the financial difficulties of those companies, yet the Elmore process itself is perfectly sound and practicable, and your directors think that there is now solid ground for believing that in the course of the present year the commercial success of the process will be shown by the working of the companies in this country and on the continent, and in that event the board anticipate little difficulty in realising for our shareholders the benefits foreshadowed in the prospectus. The board would also point out that the priority shares of the company are entitled to a *cumulative* dividend of 30 per cent. per annum; therefore, assuming that our patents and rights are re-sold at a profit, the shareholders will in no wise be prejudiced by the delay which has taken place in 1892. In the meantime every possible expense has been either avoided altogether or curtailed. With regard to the balance-sheet, it will be seen that 44,788 priority shares were allotted to the public, all of which are paid up, except an amount of £4,281, which the board have not insisted upon; first, because the money is not absolutely required; and, secondly, because the greater part of it is due from substantial individuals, and a larger interest is accruing upon the same than could be got by placing it on deposit with our bankers. The £35,424 of priority shares due to the vendors as part of the purchase-money has not yet been paid over by the company. The loan of £7,000 to the French Elmore Company, it will be seen, is well secured, and bears good interest. It was decided to make this loan after careful consideration, and with the concurrence of some of our principal shareholders, on the ground that it was a reasonable and a safe use of our working capital—not otherwise required—which would facilitate

the sale of our own property by assisting the French Company in arriving at those manufacturing results which our friends in America demand, and we have the satisfaction of knowing that our loan has contributed greatly to enabling the French Company to arrive at that measure of industrial success which is now generally recognised. The director retiring by rotation is Mr. Cooper, who offers himself for re-election. Messrs. Thomas, Wade, Guthrie & Co. offer themselves for re-election as auditors of the company.

BALANCE-SHEET, MARCH 31st, 1893.

| DR. | £ | s. | d. |
|---|---|---|---|
| To Share capital authorised—65,000 priority shares of £2 each, 35,000 deferred shares of £2 each ... | 200,000 | 0 | 0 |
| „ Share capital issued—35,000 deferred shares of £2 each, £70,000; 17,712 priority shares of £2 each. £35,424; 52,712 (allotted to the vendor company in part payment), £105,424; 44,788 priority shares of £2 each subscribed, £89,576 = 97,500 shares, £195,000; less calls in arrear, £4,281 5s. ... ... ... ... ... ... | 190,718 | 15 | 0 |
| „ Sundry creditors ... ... ... ... ... | 507 | 8 | 8 |
| | £191,226 | 3 | 8 |

| CR. | £ | s. | d. |
|---|---|---|---|
| By Cost of Elmore's patents for the United States of America and Canada, payable as to £74,576 in cash, and £105,424 in priority and deferred shares ... ... ... ... ... ... | 180,000 | 0 | 0 |
| „ Cost of plant ... ... ... ... ... ... | 1,154 | 18 | 5 |
| „ Cash at bankers ... ... ... ... ... | 1,075 | 17 | 4 |
| „ Loans to Elmore's French Company, and interest, secured as to £2,000 by a first charge upon the whole property of the French Company, and as to £5,000 by the deposit by Elmore's Foreign Company of £6,723 debenture stock of the French Company, and £20,000 debenture stock of the German Company, and lien on part of vendors' shares ... ... ... ... ... | 7,156 | 19 | 0 |
| „ Sundry debtors ... ... ... ... ... | 156 | 18 | 11 |
| „ Administration expenses during the period from the formation of the company, January 26th, 1892, to March 31st, 1893, viz., directors' fees to June 30th, 1892, including £195, which has not been drawn, £708 6s. 8d.; salaries, £829 10s. 6d.; rent, £193 13s. 4d.; patent fees, law and professional charges, £142 11s. 6d.; stationery, printing and advertising, £79 2s. 2d.; postage and telegrams, travelling and general office expenses, £51 4s. 7d. = £2,004 8s. 9d.; less interest received on deposits and loans, &c., £320 18s. 9d.; and less transfer fees, £2 ... ... ... ... | 1,681 | 10 | 0 |
| | £191,226 | 3 | 8 |

The first annual ordinary general meeting of Elmore's American and Canadian Patent Copper Depositing Company, Limited, took place on Tuesday last at the Cannon Street Hotel.

Mr. J. J. ATKINSON, the chairman, in moving the adoption of the report and balance-sheet, said the board had been considerably reduced in numbers, Messrs. Jenkin and Elmore having resigned in July last, and Sir Francis de Winton and Colonel Mosely at the end of 1892, but all these gentlemen still retained their interest and shares in the company. He thought shareholders would admit that there could be no doubt it was a wise policy on the part of the board to defer erecting plant in America until the European companies had demonstrated the commercial value of the process beyond all possible cavil. Otherwise by this time they might have spent all their money in putting up plant which would not have finally satisfied anybody so long as the French and English companies were unable to show that they were making profits, and in that way they might have had to ask for more money, whereas they had spent very little of their working capital, and there was a strong probability that they would not need to spend anything at all on plant in America in order to sell their rights. He was very pleased to say that recently distinct progress had been made with the work of the European companies, and as regarded the French company, it was being taken over entirely by a new company formed in Paris, whose capital of £80,000 in cash was over-subscribed a few days ago. As pointed out in the report, shareholders were entitled to a cumulative dividend of 30 per cent. per annum, and half the remaining profits; therefore, if they succeeded in selling their property at a profit at the end of this year, shareholders would be entitled to the whole of such profit until they had received 60 per cent. on their capital invested, and then one-half of the surplus. Such a return would be a very handsome solatium for the delay in 1892, and shareholders would in fact be getting 30 per cent. more than would have been the case had they sold in 1892. The accounts showed that the company had received £89,576 in share capital, less £4,281 unpaid calls, or a net sum of £85,295 in cash, which was accounted for by £74,576 for their patents, £1,155 for plant, £7,000 lent to the French company, £2,004 first establishment charges, and the cash in hand.

Mr. J. T. COOPER seconded the motion.

Replying to criticisms and questions from shareholders, the CHAIRMAN said that the board had drawn no fees for 12 months, and salaries were only being paid to technical experts. The whole of the company's expenses were now well under £200 a year. The loan to the French company was a perfectly legal grant, and was a first charge upon the entire property in France.

The report was, after further discussion, carried with one dissentient.

The retiring director, Mr. J. T. Cooper, was re-elected, and the auditors re-appointed, which ended the business.

## The Westinghouse Electric and Manufacturing Company, Limited.

THE directors have issued their annual report for the year ending March 31st, 1893. During that period there has been a profit from manufacturing of $1,491,817.13, and from other sources of $112,766.60, making a total of $1,604,583.73; this is after charging $298,421.04 for working expenses. The year began with large orders, but with only a moderate manufacturing capacity and a proportionate stock of material on hand, so that the above earnings were made under unfavourable circumstances, due to the fact that the capacity of the works and the material in stock and in process had to be more than doubled during a steadily increasing press of business. During the year the company has manufactured and installed at the World's Fair in Chicago an electric lighting and power plant, consisting of 12 generators of 15,000 lights capacity each, two of 4,000 lights capacity each, one 750 H.P. generator, and several smaller ones. Six of the large generators are driven by engines having their shafts connected directly to those of the generators. This plant is the largest ever installed. Although the profits of the business might have justified the payment of dividends on all of the stock of the company, the directors have thought it wise to pursue a very conservative policy, especially in view of the large expenditures required during the past year for machinery and material, and of similar expenditures which the present prosperous condition of the company's business may make necessary in the near future. Both the results and the prospects are so encouraging that the directors believe the stockholders will uphold them in a course which places the company in a position of undoubted financial strength, and which will assure the permanent continuance of dividends when once begun.

## Reuter's Telegram Company, Limited.

IN the absence of Sir John Hay, the chairman of the company, the Hon. Mark Napier presided at the ordinary general meeting of the company on Wednesday. He thought the shareholders would agree with him that it was a source of considerable satisfaction that the result of the company's operations last year was so much more favourable than what they had to report for 1891. The increase under the head of subscriptions and commissions mentioned in the balance-sheet affords the best proof of the sound state of the company's business. Against that they had, of course, increased expenditure for telegrams and agencies, necessary on the increased business of the company. With regard to the advertisement business, it was impossible to make any considerable headway until everything was in readiness. He would call the attention of the shareholders to the question of the superannuation of the staff. Although a superannuation fund had been established since 1881, no measures had yet been taken to provide a superannuation allowance to the staff. A scheme had been drawn up which provided that the staff itself should contribute 2½ per cent. of their salaries, and it was proposed by the directors that the company should provide a like amount. The scheme, however, was not absolutely settled in the details.

The scheme was approved of, and the directors re-elected.

**French Atlantic Cable Company.**—The meeting of the shareholders of the French Atlantic Cable Company held at Paris last week, under the order of the Court, has resulted in a complete victory for the French shareholders. According to the *Financial Times*, the struggle for the control of the company was between the American shareholders, headed by John Mackay, and the French shareholders, headed by M. A. Pestel. The number of shares represented at the meeting was 25,040, and a board of directors in the French group, headed by M. Pestel, was elected by a large majority.

**Stock Exchange Announcements.**—Application has been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—Montevideo Telephone Company, Limited—Ordinary shares, Nos. 1 to 15,000; 6 per cent. preference shares, Nos. 1 to 28,000. (Renewed application.)

**Brazilian Submarine Telegraph Company, Limited.**—The directors of this company, on Wednesday last, declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31st, 1893, and payable on June 24th. The transfer books of this company will be closed from June 17th to 23rd, both days inclusive.

## TRAFFIC RECEIPTS.

**The City and South London Railway Company.** The receipts for the week ending May 28th, 1893, amounted to £844; week ending May 29th, 1892, £713; increase £131; total receipts for half-year, 1893, £18,579; corresponding period, 1892, £17,087; increase £1,492.

**The Western and Brazilian Telegraph Company, Limited.** The receipts for the week ending May 26th after deducting 17 per cent. of the gross receipts payable to the London Pacific-Brazilian Telegraph Company, Limited, were £2,422.

## SHARE LIST OF ELECTRICAL COMPANIES.

| Present Issue. | Name. | Stock or Share.‡ | Closing Quotation May 25th. | Closing Quotation, June 1st. | Business done during week ended June 1st, 1893. Highest. | Lowest. |
|---|---|---|---|---|---|---|
| 195,100£ | African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer | 100 | 101 —104 | 101 —104 | 103 | ... |
| 1,247,720£ | Anglo-American Telegraph, Limited ... ... ... ... ... | Stock | 50½— 51½ | 50½— 51½ | 50 | ... |
| 2,876,140£ | Do. do. 6 p. c. Preferred ... ... ... ... ... | Stock | 91½— 92½ | 92 — 93 | 93 | 92½ |
| 2,876,140£ | Do. do. Deferred ... ... ... ... ... | Stock | 11¼— 11⅝ | 11¼— 11⅝ | 11⅞ | 11⅝ |
| 130,000 | Brazilian Submarine Telegraph, Limited ... ... ... ... | 10 | 11⅝— 12¼ | 11¼— 12 | 12 | 11⅝ |
| 36,400£ | Do. do. 5 p. c. Bonds ... ... ... ... ... | 100 | 100 —103 | 100 —103 | ... | ... |
| 75,000£ | Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ... | 100 | 107 —111 | 107 —111 | ... | ... |
| 77,978 | Brush Electrical Engineering Ordinary, Nos. 1 to 63,416 ... ... | 3 | 3⅛— 3⅜ | 3⅛— 3⅜ | 3 5/16 | 3⅛ |
| 75,000 | Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416 | 2 | 2⅛— 2⅜ | 2⅛— 2⅜ | 2 5/16 | 2⅛ |
| 125,000£ | Do. do. 4½ per cent. Debenture Stock ... ... | Stock | 108 —110 | 108 —110 | ... | ... |
| 44,000 | Chili Telephone, Limited, Nos. 1 to 40,000 ... ... ... ... | 5 | 2 — 3 | 1½— 2½ | ... | ... |
| 630,000£ | City and South London Railway ... ... ... ... .. | Stock | 37 — 39 | 37 — 39 | 37½ | ... |
| 40,000 | City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ... | 10 | 12 — 12½ | 11⅞— 12¼ | 12¼ | ... |
| 20,000 | Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 | 10 | 12½— 13 | 12½— 13 | 13 | 12⅞ |
| $7,716,000 | Commercial Cable, Capital Stock ... ... ... ... ... | $100 | 140 —150 | 140 — 150 | ... | ... |
| 224,850 | Consolidated Telephone Construction and Maintenance, Limited ... | 14/- | 3/16— 5/16 | 3/16— 5/16 | ... | ... |
| 20,000 | Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000 | 5 | 5¼— 5⅝ | 5¼— 5⅝ | 5⅝ | ... |
| 16,000 | Cuba Telegraph, Limited ... ... ... ... ... ... | 10 | 11½— 12½ | 11½— 12½ | ... | ... |
| 6,000 | Do. do. 10 p. c. Preference ... ... ... ... | 10 | 18½— 19½ | 18½— 19½ | ... | ... |
| 12,931 | Direct Spanish Telegraph, Limited, ... ... (£4 only paid) | 5 | 2½— 3½ | 2½— 3½ | ... | ... |
| 6,000 | Do. do. 10 p. c. Preference ... ... ... | 5 | 9 — 10 | 9 — 10 | ... | ... |
| 60,710 | Direct United States Cable, Limited, 1877 ... ... ... .. | 20 | 11½— 11⅝ | 11½— 11⅝ | 11⅝ | 11½ |
| 400,000 | Eastern Telegraph, Limited, Nos. 1 to 400,000 ... ... ... | 10 | 15½— 15⅝ | 15½— 15⅝ | 15⅝ | 15 1/16 |
| 70,000 | Do. 6 p. c. Preference ... ... ... ... ... | 10 | 16½— 17 | 16½— 17 | ... | ... |
| 105,900£ | Do. 5 p. c. Debs. (1879 issue), repay. August, 1899 | 100 | 108 —111 | 108 —111 | ... | ... |
| 1,294,100£ | Do. 4 p. c. Mortgage Debenture Stock ... ... | Stock | 113 —116 | 112 —115 | 114½ | 114 |
| 250,000 | Eastern Extension, Australasia and China Telegraph, Limited ... | 10 | 15⅝— 15⅞ | 15⅝— 15⅞ | 15⅞ | 15⅝ |
| 70,600£ | { Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 } | 100 | 103 —106 | 103 —106 | 105½ | 104 |
| 250,200£ | Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ... | 100 | 103 —106 | 103 —106 | ... | ... |
| 320,000£ | Do. 4 p. c. Debenture Stock ... ... ... ... ... | Stock | 114 —117 | 111 —114 | 113½ | 112 |
| 108,700£ | { Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 } | 100 | 103 —106 | 103 —106 | ... | ... |
| 146,800£ | Do. do. do. to bearer, Nos. 2,344 to 5,500 | ... | 103 —106 | 103 —106 | ... | ... |
| 300,000£ | Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909 | 100 | 101 —104 | 101 —104 | 102⅛ | 102 |
| 49,900 | Electric Construction, Limited, Nos. 101 to 45,100 ... ... ... | 10 | 2¼— 2⅜ | 2 — 2½ | 2¼ | 2⅛ |
| 19,900 | *Electricity Supply Co. of Spain, Nos. 101 to 20,000 ... ... ... | 5 | ... ... | ... ... | ... | ... |
| 100,000 | Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750 | 2 | 3/16— 1/4 | 3/16— 1/4 | ... | ... |
| 91,195 | Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ... | 2 | 3/16— 1/4 | 3/16— 1/4 | ... | ... |
| 67,385 | Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd. | 2 | 3/16— 1/4 | 3/16— 1/4 | ... | ... |
| 20,000 | Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid) | 5 | 1 — 2 | 1 — 2 | 1⅜ | ... |
| 180,227 | Globe Telegraph and Trust, Limited ... ... ... ... ... | 10 | 9⅝— 10 | 9⅝— 9¾ | 9 13/16 | 9⅝ |
| 180,042 | Do. do. 6 p. c. Preference ... ... ... | 10 | 15⅝— 15¾ | 15½— 15⅝ | 15⅝ | 15 9/16 |
| 150,000 | Great Northern Tel. Company of Copenhagen ... ... ... | 10 | 19¼— 19½ | 19½— 20 | 19⅞ | 19½ |
| 200,000£ | Do. do. 5 p. c. Debs. (issue of 1883) ... | 100 | 105 —108 | 105 —108 | 107 | ... |
| 12,134£ | Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ... | 10 | 4½— 5½ | 4½— 5½ | ... | ... |
| 2,600£ | Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000 | 10 | 6½— 7½ | 6½— 7½ | ... | ... |
| 50,000 | India-Rubber, Gutta Percha and Telegraph Works, Limited .. | 10 | 23 — 24 | 22½— 23½ | 23⅜ | 23 |
| 200,000£ | Do. do. 4½ p. c., Deb., 1896 ... ... ... | 100 | 102 —104 | 102 —104 | ... | ... |
| 17,000 | Indo-European Telegraph, Limited ... ... ... ... | 25 | 41 — 43 | 40 — 43 | 43 | 40½ |
| 11,334 | International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ... ... | 10 | 2½— 3½ | 2½— 3½ | ... | ... |
| 30,000 | †Liverpool Electric Supply, £3 10s. paid ... ... ... ... | 5 | 4¼— 4½ | 4¼— 4½ | 4⅜ | 4 1/16 |
| 10,000 | Do. do. fully paid ... ... ... ... | 5 | 6⅛— 6⅜ | 6⅛— 6⅜ | 6⅛ | 5¾ |
| 38,348 | London Platino-Brazilian Telegraph, Limited ... ... ... | 10 | 4 — 6 xd | 4 — 6 | ... | ... |
| 100,000£ | Do. do. 6 p. c. Debentures ... ... | 100 | 106 —109 | 106 —109 | ... | .. |
| 49,900 | *Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid) | 10 | 6¼— 6⅜ | 6 — 6¼ | 6⅜ | ... |
| 50,000£ | Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40 | ... | 103 —106 | 101 —104 xd | ... | ... |
| 454,747 | National Telephone, Limited, Nos. 1. to 438,984 ... ... ... | 5 | 5 — 5⅛ | 5 — 5⅛ | 5 1/16 | 5 |
| 15,000 | Do. 6 p. c. Cum., 1st Preference ... ... ... | 10 | 15 — 15½ | 14⅜— 15½ | 15½ | 14 13/16 |
| 15,000 | Do. 6. p. c. Cum. 2nd Preference ... ... ... | 10 | 14½— 14⅝ | 14½— 14⅝ | 14⅝ | ... |
| 90,950 | Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ... | 5 | 5⅜— 5⅝ | 5⅜— 5⅝ | 5½ | ... |
| 726,477£ | Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ... | ... | 112 —115 | 112 —115 | ... | ... |
| 48,800£ | New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid) | 10 | ... ... | ... ... | ... | ... |
| 6,451 | Notting Hill Electric Lighting Company, Limited, fully paid ... | 10 | 5 — 6 | 5 — 6 | ... | ... |
| 220,000 | Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid) | 1 | 3/16— 1/4 | 3/16— 1/4 | ... | ... |
| 100,000£ | Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000 | 100 | 101 —104 | 101 —104 | ... | ... |
| 11,802 | Reuter's Limited ... ... ... ... ... ... ... ... | 8 | 7 — 8 | 7 — 8 | ... | ... |
| 18,680 | St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780 | 5 | 7½— 8 | 7½— 8 | ... | ... |
| 20,000 | Do. do. 7 per cent. pref., Nos. 20,081 to 40,080 | 5 | 8 — 8½ | 8 — 8½ | ... | ... |
| 3,381 | Submarine Cables Trust ... ... ... ... ... ... | Cert. | 119 —124 | 119 —124 | 119 | ... |
| 78,949 | Swan United Electric Light, Limited ... ... (£3¼ only paid) | 5 | 3 — 3¼ | 3 — 3¼ | ... | ... |
| 37,350 | Telegraph Construction and Maintenance, Limited ... ... ... | 12 | 30 — 32 | 30 — 32 | 31½ | 30½ |
| 150,000£ | Do do. do. 5 p. c. Bonds, red. 1894 | 100 | 102 —105 | 102 —105 | ... | ... |
| 58,000 | United River Plate Telephone, Limited ... ... ... ... | 5 | 2 — 3 | 2 — 3 | ... | ... |
| 146,370£ | Do. do. 5 p. c. Debenture Stock ... | Stock | 90 —100 | 90 — 100 | ... | ... |
| 15,609 | West African Telegraph, Limited, Nos. 7,501 to 23,109 ... .. | 10 | 5½— 6½ | 5½— 6½ | ... | ... |
| 260,900£ | Do. do. do. 5 p. c. Debentures ... .. | 100 | 100 —103 | 100 —103 | ... | ... |
| 30,000 | West Coast of America Telegraph, Limited ... ... ... ... | 10 | 2 — 3 | 3 — 4 | 3⅜ | 3 |
| 150,000£ | Do. do. do. 8 p. c. Debs., repayable 1902 ... | 100 | 102 —106 | 103 —107 | ... | ... |
| 64,242 | Western and Brazilian Telegraph, Limited ... ... ... ... | 15 | 7½ - 8 xd | 7¼— 7⅜ | 7½ | 7¼ |
| 33,129 | Do. do. do. 5 p. c. Cum. Preferred ... ... | 7½ | 5⅜— 6¼xd | 5⅜— 6¼ | ... | ... |
| 33,129 | Do. do. do. 5 p. c. Deferred ... ... ... | 7½ | 1⅜— 2¼ | 1⅜— 2¼ | ... | ... |
| 178,200£ | Do. do. do. 6 p. c. Debentures "A," 1910 ... | 100 | 106 —109 | 106 —109 | ... | ... |
| 222,700£ | Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910 | 100 | 106 —109 | 106 —109 | 108½ | .. |
| 88,321 | West India and Panama Telegraph, Limited ... ... ... | 10 | 1½ - 1⅝ | 1½ — 1⅝xd | ... | ... |
| 34,563 | Do. do. do. 6 p. c. 1st Preference ... | 15 | 11½ - 12 | 11½ — 11⅝xd | 11½ | ... |
| 4,669 | Do. do do. 6 p. c. 2nd Preference ... | 10 | 9½— 10½ | 9½ — 10½ xd | ... | ... |
| 80,000£ | Do. do. 5 per cent debentures (1917) No. 1 to 1,000 | 100 | 108 —111 | 108 —111 | ... | ... |
| $1,336,000 | Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds | $1,000 | 120 —125 | 120 —125 | ... | ... |
| 169,000£ | Do. do. 6 p. c. Sterling Bonds ... ... ... | 100 | 100 —103 | 100 —103 | ... | ... |
| 59,900 | *Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ... | 5 | 5¼— 5⅝ | 5¼— 5⅝ | ... | ... |

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

**LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:**—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.—Brush Company 4¼ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1¼—2¼.—Do. 7 per cent. Preference of £5, 5—5¼.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 6¼—6⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, 6 per cent. £100 Debentures, 101—103. Bank rate of discount, 4 per cent. (May 18th, 1893).

# PROCEEDINGS OF SOCIETIES.

## Institution of Electrical Engineers.

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS. By ALBION T. SNELL, Member. (Read April 13th, 1893.)

(*Continued from page* 637.)

### 5.—TRIPHASE OR DREHSTROM CIRCUITS.

An inspection of fig. 3 will show that in order to reduce the variation of the field magnetism it is presumably necessary to increase the number of circuits. Take four with phase differences of 45°. The field excitation will be nearly constant, but eight wires will probably be required; for it is doubtful whether common returns similar to a direct current five-wire system would be practicable.

Yet, the next advance in multiphase working was made by using three circuits with currents differing by 120° in phase. Since the phase difference is increased this does not seem a self-evident improvement; but on closer study it is seen that the excitation is more constant, and that the algebraic sum of the three currents is equal to zero.

In fig. 4 let A, B, and C represent three periodic currents separated by a phase difference of 120°; and let the instantaneous values of the currents be severally represented by $c_1$, $c_2$, $c_3$. Thus,

$$c_1 = K \sin \alpha \qquad (1)$$

$$c_2 = K \sin \left(\alpha - \frac{2}{3}\pi\right) \qquad (2)$$

$$c_3 = K \sin \left(\alpha - \frac{4}{3}\pi\right) \qquad (3)$$

And $c_1 + c_2 + c_3 = 0$ by hypothesis. For

$$K\left\{\sin \alpha + \sin \left(\alpha - \frac{2}{3}\pi\right) + \sin \left(\alpha - \frac{4}{3}\pi\right)\right\} = 0,$$

which is easily proved to be the case.

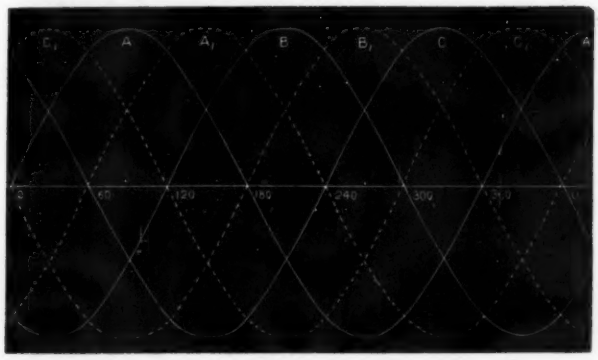


FIG. 4.

Drehstrom working is accomplished by parallel or series coupling of the circuits, the two methods being severally known as the *star* and *triangle* systems. The author regards as the field magnet that part of the machine in which the rotary field is produced. In a triphase motor, then, the field magnet will be that part which receives the Drehstrom from the mains, regardless of whether it rotates or not. In the dynamo there can be no confusion, for the field magnets, in present designs at any rate, always rotate and are excited by a separate direct current. In this paper capitals are used to distinguish the mains carrying the Drehstrom, and italics to denote the three windings on the field magnets of the motor, or the armature of the motor. Suffixes are used to mark the phase order of the circuits. It is also assumed that the effective values of the current are read by dynamometers, and that of pressure by voltmeters of the hot wire or electrostatic type.

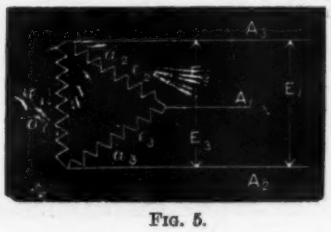


FIG. 5.

The *parallel* or *closed circuit*, or *triangle* coupling, is shown in fig. 5. Let $A_1$, $A_2$, $A_3$ be the effective values of the several currents flowing in the mains, and $a_1$, $a_2$, $a_3$, the corresponding effective currents in the coils. Also, let $E_1$, $E_2$, $E_3$ be the effective pressures at the terminals of $a_1$, $a_2$, $a_3$. And assume $A_1 = A_2 = A_3$; then $a_1 = a_2 = a_3$, and $E_1 = E_2 = E_3$. And let there be no self-induction or capacity.

With these assumptions, since $a$ is in phase with $e$, and A lies 30° removed from $a$, it follows, if the mains be fed with a combined three-phase current (as in fig. 6), that the current in one main will differ in phase by 30° from the pressure between it and the two other mains. This is seen to be the case from the geometrical relationship of the coils and the mains. And it can also be proved that the effective value of the current in each of the mains is equal to 1·732 times the effective current in each of the coils, when the circuits are equally loaded. In fig. 6A let the currents in the mains and in the coils be considered positive when flowing in the direction indicated by the arrows, and let the phase and magnitude relations of these currents be represented by fig. 6B. Then if the diagram, 6B, be supposed to revolve uniformly round its centre, the length of the projections of the sides of the diagram on any straight line will represent the instantaneous values of the corresponding currents; for it is plain that these projections satisfy all the necessary conditions, viz:—

$$\left.\begin{aligned} A_1 &= a_2 - a_3 \\ A_2 &= a_3 - a_1 \\ A_3 &= a_1 - a_2 \\ A_1 + A_2 + A_3 &= 0 \\ a_1 + a_2 + a_3 &= 0 \end{aligned}\right\}$$ All instantaneous values, *i.e.*, the lengths of the projections of the corresponding sides of fig. 6B.

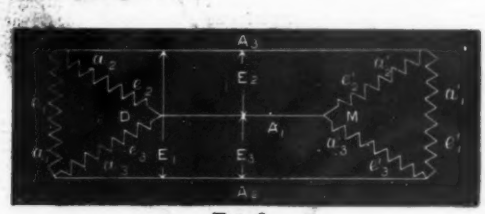


FIG. 6.

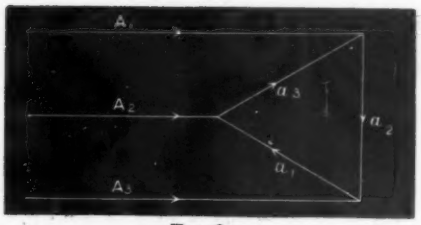


FIG. 6A.

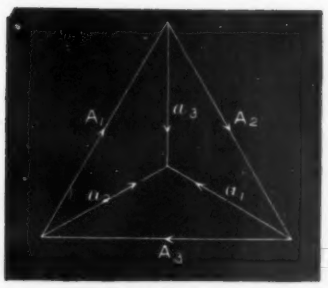


FIG. 6B.

Again, the sides of the diagram, 6B, are proportional to the effective values of the corresponding currents; and if the load be equally distributed between the three mains, then for effective values,

$A_1 + A_2 + A_3 = 0$; and $a_1 + a_2 + a_3 = 0$; and $A_1 = 2a_3 \sin 60°$; or, generally, $A = 1{\cdot}732\ a$.

The above demonstration was suggested by Dr. Sumpner.

By a similar diagram the relation between the effective pressures on the coils and mains in the *open* or *star* arrangement can be shown to be $E = 1{\cdot}732\ e$. See (*b*) of this section.

The relative position of the phases of currents and pressure in the mains and coils of a combined Drehstrom circuit of the closed type, with no self-induction, are shown in fig. 7 (E and *e* have the same

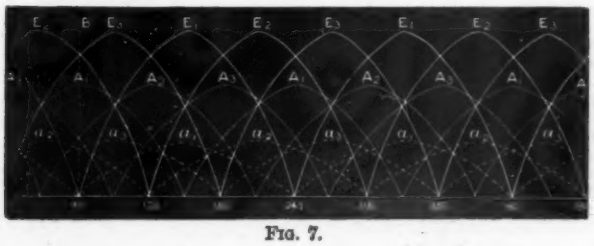


FIG. 7.

value, and coincide in phase). It will be seen that the maxima of the currents in the mains, A, are always midway between those of the coils, *a*, and that the phase difference between them is 30°.

(*b*) The *series, open circuit*, or *star* coupling is shown in fig. 8.

As before, let there be no self-induction or capacity, and let $A_1 = A_2 = A_3$; $a_1 = a_2 = a_3$; and $E_1 = E_2 = E_3$. Now, since the mains, A, are in series with the coils, *a*, and there is by hypothesis no self-induction or capacity, $A_1 = a_1$, $A_2 = a_2$, and $A_3 = a_3$. But the pressures between the mains are not the same as those at the coil terminals. And *e* will lag 30° behind E, and will be numerically equal to $\frac{E}{1{\cdot}732}$, or $e = \frac{E}{2 \sin 60°}$, and therefore $E = 1{\cdot}732\ e$.

The phases of current and pressure in a combined Drehstrom circuit of the open type are shown in fig. 9 (A and *a* have the same value, and coincide in phase).

The conclusions thus arrived at are true only on the assumptions (*a*) that the coils themselves have no self-induction, and (*b*) that both the coils and the mains are equally loaded. The first condition is never found in practice, and the second is only likely to obtain with small motors, and then only in an approximate degree. The effect of self-induction is to cause the current in the coils to lag behind the pressure at the terminals. To measure exactly the power in a Drehstrom system, then, is a complicated task; but it can always be done by measuring the work performed in each of the separate circuits, and adding the quantities.

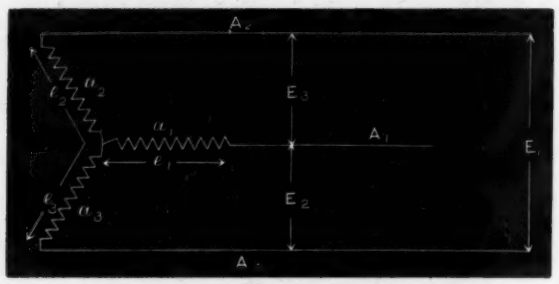


FIG. 8.

In fig. 5 the energy $= 3\ a\ e = 3\ E\ \frac{A}{1{\cdot}732} = E\ A\ 1{\cdot}732$ if the three circuits be equally loaded, and there be no self-induction or capacity.

In fig. 8, also, the energy $= 3\ a\ e = 3\ A\ \frac{E}{1{\cdot}732} = E\ A\ 1{\cdot}732$ on the same assumptions.

So it appears if there be no self-induction and an equal load in each circuit that the number of ampères in one of the mains multiplied into the pressure between two mains into 1·732 gives the power in watts. If there be self-induction, the above quantity must be multiplied by the cosine of the angle of lag between the current and the pressure. The energy absorbed by a motor, therefore, will be expressed by $E\ A\ 1{\cdot}732 \cos \phi$, where $\phi$ is the angle of lag.

If the three circuits be equally loaded, the power can be measured by one wattmeter (see fig. 9A). Put the current coil in one of the mains, say $A_2$, and take two readings, one with the pressure coil coupled between $A_1$ and $A_2$, and one with it coupled between $A_2$ and $A_3$. The power will be equal to the sum of the two readings.

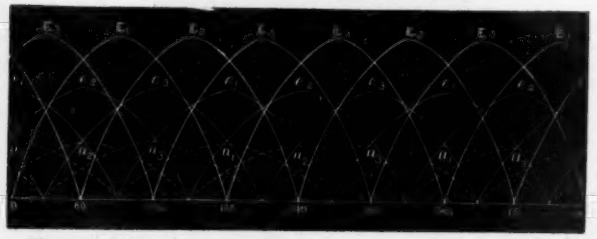

FIG. 9.

And if the load be unequally distributed, two wattmeters are required (see fig. 9B). Place the current coils in two of the mains, say $A_1$ and $A_3$, and couple one pressure coil between $A_1$ and $A_2$, and the other between $A_2$ and $A_3$. The power is then the sum of the two wattmeter readings.

The author is indebted to Dr. Sumpner for the above methods of measuring the power in multiphase circuits by wattmeters. They are also applicable for reading power with direct currents.

In part (*a*) of this section it was shown that with combined three-phase currents, even when neglecting the self-induction of the coils, there is a constant phase difference between the current and the line pressure. This, although not in itself a direct loss, is the cause of great difficulty in measuring, regulating, and controlling the currents, and also reduces the output for a given weight of material. Hence it has been found expedient to work the dynamo circuits unconnected, and to use six or more separate coils. The currents from these are combined by a suitable transformer so as to convert the secondary currents into a combined high tension rotary current with phase differences of 120°. This high-pressure current is reduced at the motor end of the line by another suitable transformer and sub-divided as required. In the transformers, says Mr. Dobrowolski, there is not the same constant difference of phase of 30° (between the current and the pressure), but, owing to the connections of the secondary coils, the transformation ratio is not equal to that between the primary and secondary turns; so the latter must be increased to the extent of this difference. The ratio is 2 : 1·732, or a difference of 14 per cent., neglecting all losses from other causes than the connections. The efficiency of Drehstrom transformers is probably not quite so high as that of single-phase ones, but it is not much less; and when the advantages of low pressure dynamos and motors with high pressure transformers is fully appreciated, the slight difference in efficiency appears insignificant.

The next point for consideration is the pulsation of the magnetism in the rotary field. This is not a simple matter to represent in a graphic manner, for the magnetic field is not merely the result of the *inducing* currents in the Drehstrom coils; but it is also largely affected

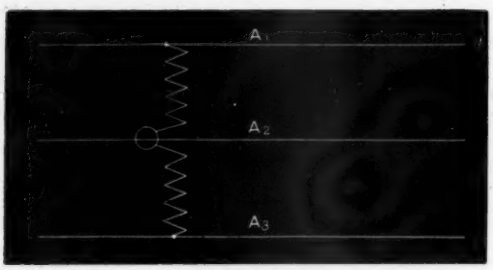


FIG. 9A.

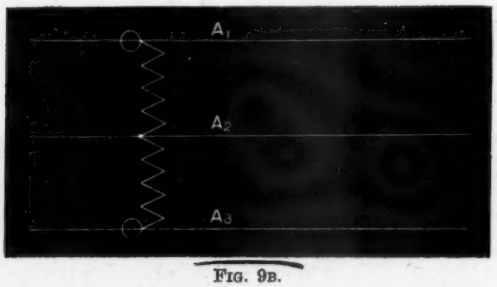


FIG. 9B.

by the frequency and magnitude of the *induced* currents in the closed coils of the armature, which vary from instant to instant with every fluctuation of load. The frequency of the induced currents will always be less than that of the exciting current—attaining its highest value at full load when the slip of the armature is greatest. It is expressed by $\frac{N - n}{60}$, where N = the number of revolutions of the magnetic field per minute, and $n$ = that of the armature. (If $N = 2{,}400$ and $n = 1{,}920$, then the frequency will be 8 per second.) The average pressure acting in the closed coils will be given by the expression $K, C, F, a, 10^{-8}$,

where K = a constant,
C = the number of turns counted all round the periphery of armature,
F = the average number of lines of force from one pair of poles,
and *a* = the number of alternations per second of the armature induced currents.

In determining the excitation for multiphase motors and dynamos, it is therefore necessary to make two calculations, one for full and one for light load, just as with direct current machines.

It is clear that it is not possible to represent the changes of the rotary field magnetism by a general diagram. Fig. 10 shows diagram-

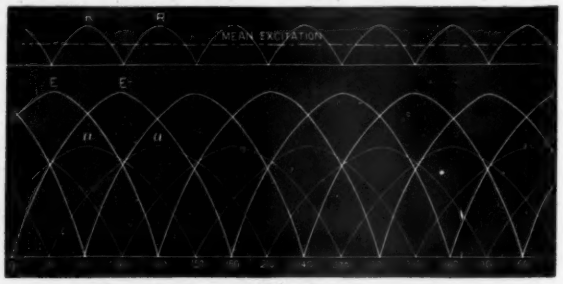


FIG. 10.

matically the relative position of the current and pressure curves in a combined Drehstrom circuit, with the resultant excitation, assuming the armature reactions to have no effect—*i.e.*, the field and armature are supposed to rotate at nearly the same speed. An arbitrary angle of lag of 30° between the pressure and the current in the exciting coils has been assumed, and the curves have been drawn to suit the sine law. The pressure is shown in $E_1, E_2, E_3$, and the current in $a_1, a_2, a_3$. The resultant excitation is indicated in curves R, R, R, the limits of

which are 2 $a$ and 1·732 $a$, the mean difference of about 7 per cent. If the magnetism varied as the excitation, then the same fluctuation would occur in the rotary field, but owing to hysteresis and eddy currents the mean variation is probably not much more than half as great, say from 4 to 5 per cent.

Now the torque will vary with the ampère turns, the frequency of the current, and the number of lines of force in the armature; or, the torque $= \frac{C\, i_a\, F\, a}{K_1}$, where $i_a$ = the armature current, and $K_1$ = a constant, and the other symbols have the same signification as above. The magnetism is determined by the field excitation, and the number of turns of wire is of course fixed for a given armature; hence, to increase the torque, it is necessary that the armature rotate more slowly.

This "slip" increases both the frequency and the magnitude of the armature current, thereby weakening the resultant field and lowering the counter E.M.F. of the field magnet coils, and allowing more current to flow in the exciting circuit. But since the total magnetism decreases as the armature current increases, there is a point at which the torque is a maximum. This corresponds to a definite current,* which is not the starting or maximum current, and hence these motors do not exert their greatest effort at starting. In order to avoid large rushes of current when closing the exciting circuit, it is advisable to insert variable resistances in series with the armature windings. This is specially necessary with large machines, and it appears probable from this reason, as well as from other considerations, that large Drehstrom motors will always be designed with stationary armatures and revolving field magnets.

So far, if the difficulty of measuring the power be disregarded, the main point calling for improvement appears to be the magnetic pulsation. The mean variation does not, theoretically, exceed 7 per cent., and, practically, probably not 5 per cent. In order to still further decrease this, Dobrowolski has devised a very pretty combination of the open and closed type windings, which reduces the mean variation of the excitation to 3·5 per cent., when the magnetic field should be practically constant. The winding is shown diagrammatically in fig. 11, and is known as the double-linked winding. The

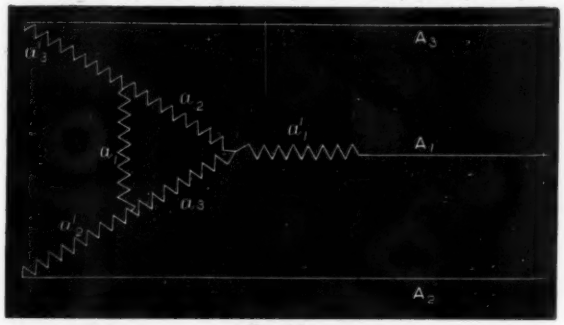


FIG 11.

coils indicated by the symbols, $a^1_1$, $a^1_2$, $a^1_3$, are severally wound in two parallels, 15° removed from the closed coils, $a_1$, $a_2$, $a_3$. The complications involved are considerable, and the gain perhaps not commensurate with them, yet for large machines the device may prove useful.

There are some important points to be noticed between the *series* and *parallel* connections. It has been shown that with the *series* coupling $= \frac{E}{1{\cdot}732}$ (see fig. 8), and that the currents in the coils and mains are the same; and in the *parallel* device (see fig. 5), that each coil carries a current equal to $\frac{A}{1{\cdot}732}$, and that the pressure at the coil terminals corresponds to the pressure between the mains. These differences are suggested by the terms *parallel* and *series*, which are in this respect more apt than those of *triangle* and *star*.

Now the magnetising effect exerted by a given number of turns of wire, and a definite effective current in the mains, will be different with the two kinds of windings.

Consider figs. 12 and 13, which severally represent the *parallel* and *series* coupling, and the direction of current at the instant when the Drehstrom is entering by one main and returning equally by the two others. Let $n$ be the number of turns of wire in one coil. Then the total ampère-turns in the *parallel* device is $n$ A, and in the *series* arrangement $\frac{3}{2}\, n$ A. Therefore, the magnetising effect and also the self-induction of the *series* device is greater than that of the *parallel* for a given current and a fixed number of turns. Now, the total power absorbed by the two circuits may be made the same by proper adustment of pressure and frequency; but since the lag is involved, a complete solution is not very simple. Probably, however, a few experiments made with different-sized machines will do more to assist the constructor than pages of mathematical theory.

It must be borne in mind that the triphase system has not been definitely proved to be superior to the diphase, and the leading authorities on the subject differ strongly. Herr Dobrowolski says that "the diaphase current now belongs to the past," because, in practice, machines give curves departing so widely from sine functions. He admits, however, that if the phase differences of current and pressure be the same in each of the two circuits, and *follow a sine law*, the work is the same in each at the same instant. Messrs. Brown, Kelly, Stanley, and Kapp all maintain that there is little to choose between the two systems from this point of view; and Mr. Brown further states that "his

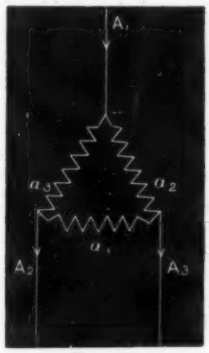


FIG. 12.

FIG. 13.

extensive experience with multiphase currents shows that two or three-phase motors of similar outputs are much the same machines with regard to their respective efficiency, starting torque, weight, and apparent watt consumption. This holds good for synchronous as well as non-synchronous machines." It is generally admitted that the Drehstrom presents many difficulties for lighting, and still more for a combination of lighting and power work; but continental engineers have to a large extent successfully overcome these; whereas, on the contrary, the diphase system admits of as a simple treatment as the single phase one. It appears to be therefore probable that, if multiphase currents come into general use, the diphase may be employed chiefly for combined *light and power distribution*; and that the Drehstrom may find its field of usefulness in *transmission* and *distribution of power*. Experience alone can settle these points.

*(To be continued.)*

* It is clear that the particular current for maximum torque is dependent mainly on the magnitude of the armature reactions, and if the latter were sufficiently small the greatest torque might be obtained at starting, as is the case with a series wound direct current machine. With commutatorless Drehstrom motors it is probable, in the author's judgment, that the maximum effort will be obtained with a current little greater than that required for the greatest output.

## NEW PATENTS—1893.

9,662. "An electric lamp for bicycles, tricycles, vehicles, and all kinds of rolling stock." J. E. B. WALKER. Dated May 15th.

9,664. "Improved plug for combination electric candle fitting." CH. MELLIER & Co. (G. Dinlacher and B. A. Lacoste). Dated May 15th.

9,670. "An electro-chemical purifying process in iron making, and for other purposes." S. D. WILLIAMS, W. J. CLAPP, and G. H. LLEWELLYN. Dated May 15th.

9,699. "Improvements in connection with connecting joints for electric mains, telegraph wires, and telephones." W. GORDON. Dated May 15th.

9,716. "An improved method and apparatus for the production of electrical effects in ballets and other theatrical representations." W. DEFRIES and V. I. FEENY. Dated May 15th.

9,753. "Improvements in electrical and other measuring instruments and apparatus." W. E. AYRTON and T. MATHER. Dated May 16th.

9,779. "Circuit switch." C. A. ALLISON. (Communicated by the Electrical Specialty Company, United States.) Dated May 16th. (*Complete.*)

9,780. "Improved electrical apparatus for obtaining light." F. V. WOOD. Dated May 16th. (*Complete.*)

9,805. "Improvements in contacts for making and breaking electrical circuits." SIEMENS BROS. & Co., LIMITED, and F. JACOB. Dated May 16th.

9,810. "Improvements in or connected with incandescent electric lamps." H. C. BULL. Dated May 16th.

9,818. "Improvements in underground conduits for electrical conductors." J. F. CUMMINGS. Dated May 16th. (*Complete.*)

9,819. "Improvements in electric circuit-controlling devices." W. P. HALL. Dated May 16th. (*Complete.*)

9,821. "Improvements in galvanometers." H. H. LAKE. (Communicated by the Whitney Electrical Instrument Company, United States.) Dated May 16th. (*Complete.*)

9,864. "Improvements in electrical switches." R. G. EVERED and A. WATSON. Dated May 17th.

9,906. "Improvements in the manufacture of elements or electrodes for voltaic batteries, and electrolytic decomposition cells" D. G. FITZ-GERALD. Dated May 17th.

9,965. "Improvements in or connected with the working and welding of metals by electricity." A. LONGSDON. (Communicated by the firm of F. Krupp, Germany.) Dated May 18th. (*Complete.*)

9,997. "Improved method of generating electricity direct from heat." S. COXETER and H. NEHMER. Dated May 18th.

10,015. "Improvements in apparatus for use in the utilisation of electrical energy for culinary purposes." R. E. B. CROMPTON and H. J. DOWSING. Dated May 19th.

10,042. "Improvements in and apparatus for the manufacture of plates, grids, or supports for secondary batteries." F. KING. Dated May 19th.

10,048. "A current governor for electromotors." H. W. BUDDICOM. Dated May 19th.

10,056. "An improvement in commutators for electric machines." C. OLIVETTI. Dated May 19th.

10,081. "Improvements in and relating to electromotors." W. GREENHALGH. Dated May 20th.

10,095. "Improvements in electroplating." E. DE PASS. (Communicated by H. Thofehrn, France.) Dated May 20th.

10,107. "An improved telephone call." J. H. KINSMAN. Dated May 20th.

10,129. "Improved electrical conductor." H. EDMUNDS. Dated May 20th.

10,130. "Improvements in means for supplying current for driving vehicles on electric railways or tramways." H. PIEPER. Dated May 20th.

10,134. "Improvements in the construction of armatures for dynamo-electric machines." W. B. SAYERS, H. A. MAVOR, W. A. COULSON, and S. MAVOR. Dated May 20th.

10,142. "Improvements in and relating to electric machines." W. FRITSCHE. Dated May 20th.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

18,733. "Improvements in and connected with electric telephonic apparatus." A. MARR and A. T. COLLIER. Dated October 30th. The inventors make the magnet of the telephone much larger and heavier than usual, and arrange it in connection with the apparatus in such a manner that it can be drawn, moved, or swung into a convenient position relatively to the ear of the person using it, whilst still being supported by the board, box, casing or apparatus with which it is connected. 2 claims.

18,773. "Improvements in and relating to apparatus for the transmission and reproduction of sounds." T. J. HOWELL. Dated October 30th. The inventor constructs an electro-magnetic telephone with magnetised pieces of steel which extend across the case of the instrument, and which are bent so that their ends are in proximity to the diaphragm or tympan; the said magnetised pieces are securely held in place by a bolt of soft iron, upon which is placed an ordinary coil of insulated wire, thus forming an electro-magnet. These magnetised pieces of steel considerably increase the effectiveness of the instrument as an electro-magnetic telephone. He places one or more carbon plates or discs in the back of the case of the instrument behind or between the magnetised pieces of steel, and secures them in place in any convenient manner; for instance, by means of the aforesaid bolt. He then fills up the space within the case and around the electro-magnet with powdered or granulated carbon. On the top or in front of the granulated carbon he places another carbon plate or disc, which is kept in contact with the granulated carbon. The back or inner carbon plate is connected with one of the leading-in wires. 3 claims.

19,211. "Improvements in or relating to electric meters." F. TEAGUE and E. F. MOY. Dated November 6th. Relates to improvements in electric meters of the class described in the specification to letters patent No. 15,489, of 1889, and the specifications to applications No. 389, of 1891, and No. 6,633, of 1891.

19,450. "Improvements in electric apparatus." T. E. MARSH and WOODHOUSE AND RAWSON UNITED, LTD. Dated November 10th. Consists in arranging on a bar, working in suitable guides, a coiled spring or springs. To one end of the said bar is attached a spring catch engaging with a ratchet wheel, having a suitable number of teeth, the latter operating a switch, so arranged that the current is only made or broken at suitable intervals, according to the number of teeth embraced by the said catch on the ratchet wheel, and the number of arms and contacts of the switch. 1 claim.

18,561. "An improved method of laying wires and cables in pipes or conduits." A. R. BENNETT. Dated October 28th. According to the invention, the draw wire is dispensed with and replaced by steam, compressed air, or other gas, or hydraulic power, acting on a piston which fits true to the interior of the pipe, and has attached to it the cable to be laid. 2 claims.

19,546. "Improvements in alternating current dynamos. W. HARTNELL. Dated November 11th. The generator coils are partially embraced, at equal intervals, by a series of electro-magnets, shaped like the letter E, forming a channel wide enough to cover two coils and the space between them, the bottom of the magnets being flush with the inside of the coils. The magnets are placed around the coils, and arranged alternately to cover the centre and right-hand coil, and centre and left-hand coil. The armatures revolve inside the coils; they are straight, and extend to the outsides of the magnets. There are as many armatures as there are pairs of magnets. 8 claims.

19,625. "Improvements in ceiling roses and wall sockets for electric lighting." A. GRUNDY. Dated November 12th. Relates to a ceiling rose or wall socket made in three distinct pieces. First, a base to fix to the wall or ceiling in the usual manner, carrying suitable terminals or binding posts for the supply leads. Also contacts for making connection with the second part of the fitting. A plug or contact piece, to which the flexible wires of the pendant or other electric fitting are connected, fitting into the former. Also a cap or cover attached to the first-mentioned by a screw thread, or by screws, so as to prevent the plug or contact piece being accidentally drawn out. 2 claims.

19,630. "Improvements in electric cables." G. G. M. HARDINGHAM. (Communicated by Messrs. Felten & Guilleaume, of Mulheim.) Dated November 12th. A telephone cable constructed according to this invention comprises several strands twisted together and sheathed with lead or other suitable protecting material. Each strand consists, by preference, of four flat wires, or metallic ribbons, each insulated from the other by means of a wrapping of paper, or other suitable material. The four, or other number of flat wires, are arranged flat-wise, one upon the other, so as to form a bar, or bundle, approximately square in cross section, and the bundle is then twisted. This latter treatment has the effect of fixing and permanently retaining the several conductors in position in relation to one another. The strand is, in addition, served, either before or after the twisting operation, with a coating of paper or other insulating material. 4 claims.

19,854. "Improvements in dynamo brushes." J. DICKSON and R. G. SHAPCOTT. Dated November 16th. The inventors take copper wire and plait the same, and then compress it so as to produce a flat band of the desired width, which band is enclosed in a jacket or sheath of copper gauze.

19,899. "Improvements in telephone closets, and other structures, where it is desirable that they should be practically sound proof." T. WEIGHILL. Dated November 17th. The inventor forms the walls, in all cases, of two thicknesses, at the corners or other points where there may be posts. These posts are preferably lined on the inside, or outside, or both, with a sheathing of wood or other material, and where two posts unite, and at the doors where the two frames of the door come together are arranged rabbets or tongue pieces in one fitting into the holes of the other, and forming a double frame, the joint of one frame being further back than the joint of the other. The main walls of the structure are formed hollow of panelling or boards, and between these there is filled in fibrous peat worked up light, like as in the case of peat used for horse litter, it being the fibrous portion of the peat teased out to a light woolly consistency; this is mixed with sawdust, and packed loosely between the frames. 2 claims.

19,914. "Improvements in or connected with electric arc lamps." J. B. BARTON. (A communication from abroad by W. Jandus, of America.) Dated November 17th. Consists of a Jablochkoff candle enclosed in a rarefied glass vessel. 8 claims.

20,139. "Improvements in electric signals or indicators." J. T. GENT, A. W. STAVELEY, and I. H. PARSONS. Dated November 19th. The foundation plate is formed by stamping the same out of a piece of sheet brass or other suitable metal. The magnet, which is an ordinary horse-shoe magnet having a coil or bobbin upon one leg, is arranged with its poles projecting through an arm bent up from the base plate in such a manner that the armature, one end of which is arranged as a catch to support the arm carrying the signal disc, is directly acted upon by both poles of the magnet. The armature is also made out of a piece of stamped iron, instead of cast iron or brass, as hitherto. 1 claim.

20,214. "Improvements in electropathic appliances." D. WHITE. Dated November 20th. Consists in the adaptation of perforated zinc plates, in and through which plates copper wire is interlaced or otherwise combined therewith. The plates of perforated zinc are cut to any convenient sizes, suitable to the part of the body to which they are to be applied; and one, two, or more lengths of copper wire is, or are, interlaced in and through the perforations of the zinc plate. When the plate is made in the form of a band, the two ends of which are intended to be temporarily joined by a buckle or otherwise; such joint is so made that metallic contact is ensured, so as to keep the elements continuous. 2 claims.

20,230. "Improvements in electric arc lamps." J. H. RIDER. Dated November 21st. In a lamp constructed in accordance with this invention, the shunt solenoid can be made more powerful than the series or main circuit solenoid, and thus the regulation of the lamp is less affected by variations in the main current strength and more directly controlled by the shunt solenoid. 2 claims.

## CARBON MANUFACTURE IN ENGLAND.

CONSIDERING the natural advantages which, owing to the large consumption of gas in this country, would facilitate the manufacture of electric light carbons it is a curious thing that these have not been taken in hand more boldly by English firms. The demand for arc light carbons is constantly increasing, and although but a few of the projected public lighting schemes are so far at work, there is a steady importation of foreign carbons to meet present requirements. The nature of English coal and the method employed to carbonise it in the

coal in the retorts causes the bye product coke to be a most suitable raw material for the carbon maker.

An engineer has mooted the idea of reducing the consumption of carbon rods by attaching an arrangement to arc lamps, which will reduce the rate of burning without appreciably affecting the light. If this can be done, and results prove the assertions as to the utility of this invention, arc lighting will receive a great impetus. The reduced cost per annum will be so marked that the number of new schemes will more than make up for the reduction in carbon consumption per lamp. What is wanted is a cheaper and better arc carbon than the one which is generally met with on the English market.

The Welsh steam coal, which is so generally met with in this country, has received a more thorough petrification than the brown coal so common on the continent; the resultant bye products are better in every way for carbon-producing purposes. The extended use of arc lamps in this country, and the use which it is proposed to make of such means of lighting, renders those supplied by the English market the largest consumers of carbons in the world.

Tentative attempts have been made from time to time to manufacture arc carbons in this country, but the results have not been very encouraging to those financially interested in such projects. In the business, trade secrets and experience are of greater value than the mere question of plant, although the latter has an important bearing upon the results.

At Brymbo, near Wrexham, this new industry has been given a local habitation, due to the initiative of a well-known London firm, and the English Carbon Company, Limited, will be ready to supply English carbons manufactured from home material by local labour in time for the coming lighting season. The company claim that they can defy competition as to price or quality. This is as it may be, but we do know that the machinery and system of manufacture is based upon and guided by that used and the experience gained by probably the largest manufacturer of carbons on the continent, certainly one of the best known and most successful.

The American style of laterally moulded carbon is one of the most fruitful sources of complaint against the adoption of arc lamps, and as with the proper machinery it is as economical to produce die-pressed carbons which do give satisfaction, the plant erected at Brymbo is on the latter principle. Even with the best plant, unskilled labour and experimental management handicaps production and tends to finally wreck the concern, as we have seen not very long ago with two attempts to carry out this branch of industry on English soil. To avoid this the English company have the right to all the trade secrets, modes of manufacture and skill which many years of experience have given the Continental firm already referred to. This valuable aid, coupled with better material rather than better manufacture, gives hope of the profits of deals on the English markets remaining at home instead of going into the pockets of concerns abroad. Considerable interest has been aroused in some quarters by the rumour that the Wrexham works were in a position to carry out contracts, and there can be little doubt as to the importance which this announcement possesses to the large users of arc lamps, such as municipal engineers and others.

A well-known London electrical engineer has acted as consulting engineer to the company, and has advised them to take up the question with which they have to deal scientifically as well as technically. The results of extended and practical experiments will most probably be published, and should be of use to arc lampists. The officers of the company include Mr. John H. Darby, as chairman, and T. G. Littleboy, as manager and secretary.

## CORRESPONDENCE.

### Paralleling of Alternators.

We have read with much interest Mr. Charles H. Yeaman's communication in your last issue with reference to the above subject, and as this matter is of general interest, we are sorry that Mr. Yeaman has not mentioned the station laid down by him where "parallel running is regularly practised," as we have certainly been for some time under the impression that in England only in those works laid down by us has parallel running been so practised.

We are quite aware that it is the custom of other engineers to claim that in their works the alternators run in parallel, and that they do, from time to time, succeed in making them so run, but we are sure that the best thanks of the profession will be due to Mr. Charles H. Yeaman if he demonstrates beyond any question of doubt that the stations equipped by Ferranti and Mordey-Victoria machines have been from the start, and are now, depending regularly upon parallel running.

Mr. Yeaman tells you that he once had occasion to look closely into this subject, and it is to be regretted that his observations led him somewhat astray. In the first place, he ought to have found out that the title of "pioneers of parallel running" in England is due to ourselves, and not to Mr. J. S. Raworth and Mr. W. M. Mordey. We refer him to the evidence which was given before Major Marindin at the Board of Trade enquiry held in London in April, 1889, where one electrical engineer after the other acknowledged that parallel running had not yet been successfully accomplished, and where, however, our engineer, Mr. William Lowrie, was the only one who gave evidence to the effect that parallel running was not only quite possible, but was actually being done at that very time at the West Brompton Station of the House-to-House Company, laid down by us.

This was considered so interesting a piece of evidence that Major Marindin and Major Cardew, at the close of the proceedings, accompanied our Mr. Robert Hammond and Mr. Lowrie to the works at West Brompton to see the parallel running carried actually into effect, the demonstration proving most conclusive.

At that particular date in London, alternating currents were only supplied by the House-to-House Company, the London Electric, and Mr. Pritchett's Works, Rathbone Place, now the property of the Metropolitan Company. We think Mr. Yeaman will discover, if he carries his investigations further, that neither of the latter were arranged for parallel running, whereas the West Brompton works, which were opened on January 24th, 1889, and all other works laid down by us, have been so arranged.

Mr. Yeaman's reference to Newcastle is an unfortunate one, because we believe, to the great regret of the Brush Company, *continuously successful* parallel running at Newcastle has never been attained.

**Hammond and Company.**

### Cooking and Heating by Electricity.

The controversy on this matter, which is at present going the round of the press, has developed into a form which is neither useful nor instructive, and has no bearing on the actual question involved. Mr. Dowsing tries to compare the cost of electrical heating with that of coal, a comparison which is impossible, as the conditions required are totally different.

Mr. Dowsing gives no exact figures to calculate from, as to the total available heat per ampère hour, and it is possible that the heating apparatus at present used may be greatly improved; the first apparatus designed can hardly be considered as final, although Messrs. Crompton may be fairly credited with the first practically successful attempt to utilise electricity for domestic heating purposes.

Taking Mr. Dowsing's own figures, with electricity at 5d. per unit, it requires about 3½ ampères for 10 minutes to boil one quart of water, the cost being one-third of one penny. With the water at an initial temperature of 62° F., this gives an expenditure of 375 units of heat in useful work, a cost rate of 1,125 units for one penny.

The only fuel which can compare with electricity is ordinary coal gas, which can be used under the same conditions, and with the same regard to economy, in small and irregular work. One cubic foot of coal gas, as supplied in London, has a total heating power of 660 units, and of this, over 600 units are obtained in actual work in many commercial forms of bath heaters. In boiling a small kettle over an atmospheric burner, the average duty in practice will not exceed about 400 units, *i.e.*, less than two-thirds the total theoretical work. If we allow a further margin, and reduce this to 375, one cubic foot of London gas will give at least the work of 3½ ampères for 10 minutes, and 3 cubic feet, costing one-tenth of a penny, will do the work specified by Mr. Dowsing, as costing one penny for the electricity used. No doubt each will have its own place, and will fill certain special requirements; but it is certainly a mistake to attempt to prove that electricity is, at present, a cheap source of heat.

No doubt the duty actually obtained from coal gas is very much higher than it was at first, and electricity has the very great advantage that its practical application is in the hands of trained experts, and has been so from the first; possibly no industry in the world has so large a proportion of competent manufacturers and first-class workmen, who understand both the theory and the practice of their work.

The application of coal gas as a fuel, on the contrary, has been under a cloud for years, discouraged by the old proprietary companies, and hampered, as it has been, and still is, by want of knowledge of the simplest natural laws on the part of most of the men who have to make and fix the appa-

ratus. It is only now beginning to emerge from a state of chaos; but when it has been thoroughly established on a proper scientific basis, the manufacturers of coal gas will have no more to fear for its future than they have now from the beautiful old moderator lamps, which are so charming and so expensive, in our drawing-rooms and picture galleries. All are not fortunate enough or rich enough to have electric lighting, or to put in special ventilators for the removal of the products of combustion. When the purveyors of either gas, electricity, or moderator lamps assume the possession of perfection and infallibility, they only lay themselves open to attacks which are not always tempered with justice or discretion, and which cause a very unnecessary ill-feeling.

**Thos. Fletcher, F.C.S.**

Warrington, *May 24th*, 1893.

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The error in my letter published in the ELECTRICAL REVIEW of May 19th, in stating "one quart" instead of "one pint" is so palpable, that every engineer must have known what was meant. The heat units generated by the current mentioned at 100 volts would boil about 1·3 lbs. of water at 60° F. in ten minutes, but allowing for loss of heat, one pint could easily be boiled in this time. I do not, however, consider that the ordinary forms of kettles, saucepans, &c., are the most suitable for electric heating; even the gas engineers have accustomed us to large flat-bottomed apparatus not previously employed. I am now making a new type of boiling arrangement specially suitable for use with electric heaters, which will, I believe be a great advance on all others. It is interesting to hear from so eminent an authority as Mr. Thomas Fletcher that coal cannot be compared with electricity. This is exactly my opinion. Just as gas when used for boiling purposes, affords many advantages over coal, so electricity will outstrip its rival for heating, exactly as it is doing for lighting.

It is not my intention to enter into a long controversy upon the merits of electricity in its latest phase, for this is unnecessary. The enquiries and orders we have in hand are sufficient proof of the public interest in this new departure. It is a mistake to consider that the expenditure of a few pence extra in cooking a dinner will deter those who have electricity available from using electrical cooking apparatus, particularly when it can be shown that the food is cooked in an absolutely pure atmosphere, and in the most perfect manner. There is no doubt that the old adage of "The proof of the pudding is in the eating" comes in with greater force in the present instance than is often the case. Full particulars of trials will be published shortly, and I prefer to let these speak for themselves, rather than discuss the theoretical possibilities of using electricity in this direction. The cost of using the apparatus is, of course, an important item, but I am satisfied that wherever the current is sold at a reduced price during the daytime, when most cooking operations are carried out, it can be used in competition with many other forms of apparatus now employed.

I remember some 10 or 12 years ago that we were treated to long articles in journals interested in gas supply, *proving conclusively* (so they said) that electricity could never be supplied at a price that would be cheap enough to bring it into use for lighting purposes. The same thing is now happening with regard to the use of electricity for cooking and heating purposes; but as current is not only available, but in extensive use at the present time, I have no fear that as soon as the advantages of electrical cooking and heating apparatus are known, electricity will be used for these purposes also.

**H. J. Dowsing.**

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I can endorse Mr. Dowsing's remarks, in his able letter on cooking by electricity, except in one particular. The conclusion at which he arrives, that electrical cooking can be performed at a cheap rate, comparing favourably with the cost of cooking by coals, is doubtless correct, and this fact cannot be made too widely known; this more especially among the electrical trade, as an idea seems to prevail that cooking "takes a frightful lot of current."

I am now making cooking apparatus which will cook a small leg of mutton or a fowl, with about 5 lbs. of potatoes and cabbage, with an expenditure of current equal to about two-thirds of a unit.

The following test with one of our ovens will show you some data, which, however, I think I can still improve upon :—

| Time. | Temperature. | Current. | Pressure. |
|---|---|---|---|
| 0 minutes. | 12° C. | 9 ampères. | 100 volts. |
| 5 " | 49° C. | 9 " | 100 " |
| 10 " | 108° C. | 9 " | 100 " |
| 15 " | 180° C. | 9 " | 100 " |
| 20 " | 225° C. | 9 " | 100 " |
| (The current reduced after 20 minutes.) | | | |
| 25 minutes. | 205° C. | 3·5 ampères. | 100 volts. |
| 30 " | 195° C. | 3·5 " | 100 " |

The temperature remains steady at 195° C., with 350 watts, for three hours after this.

The exception which I have to make to Mr. Dowsing's figures refers to boiling water. He does not state the initial temperature of the water to be boiled, but simply says: "To boil one quart of water requires about 3½ ampères for 10 minutes." This state of efficiency I have not been able to reach, nor can I understand how Mr. Dowsing can attain it, as it is beyond the theoretical efficiency, calculated upon Joule's law. This law teaches us that 1 watt acting for one second develops ·238 calories, or, in other words, raises ·238 gramme of water 1° C. in one second. Taking one pint of water to weigh 1¼ lbs., and the initial temperature of water at 15° C., we can calculate that 1,000 watts will boil such water (or raise the temperature by 85° C.) in 3·383 minutes.

I am now selling copper kettles which will perform this operation with an expenditure of current which equals 1,000 watts for 3·8 minutes per pint, and which gives about 90 per cent. of theoretical efficiency. More than this I have not been able to achieve.

As it has not yet been publicly stated, I may mention that my method of manufacturing electric cooking and heating apparatus (as carried out by my firm, the General Electric Company, Limited) differs essentially from the American and Crompton methods (which I myself introduced into this country at the Exhibition in the Crystal Palace), and I claim that I have, by this process, gone an important step in advance.

The insulating and refractory material is a cement which can be applied to the surface to be heated without baking. I have found that enamel, which is being used in the American method, cracks, and therefore reduces the protection aimed at, viz., that of excluding atmospheric oxydisation.

The cement has no deteriorating influence on the resistance wires, allows the use of an extremely thin film of insulating division between such wires and the surface to be heated, and thus renders the apparatus very durable and efficient.

**The General Electric Company, Limited,**
G. BIESWANGER, *Director.*

*May 24th*, 1893.

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A sentence in your article on "Electric Cooking and the Load Factor" seems to give support to a delusion, already widely spread, that a vacuum, for instance that of an ordinary incandescent lamp, in some mysterious way prevents the heat generated in the filament from passing to the outside of the lamp. Will you, therefore, allow us to call the attention of your readers to the fact that an ordinary incandescent lamp, run, if preferred, at a low efficiency so as to be durable, is, for many purposes, the cheapest and most efficient electric heater that can be devised.

The reason of this is easy to see :—(1) No cheaper form of resistance can be manufactured than an incandescent lamp. (2) Only a very small weight of material, viz., the filament and to some extent the glass must be heated in order to heat anything else. An incandescent lamp is, therefore, particularly suitable for intermittent heating, as it becomes hot and cold again almost instantly, having no storage capacity for heat.

Putting these ideas into practical form we have patented an apparatus in which the resistance is an ordinary incandescent lamp. Full particulars will be published shortly, but meanwhile we may say that a 50 C.P. lamp taking 170 watts will heat one pound (⅛ths of a pint) of water from 20° C. to 100° C. in 20 minutes, although a small loss of heat is allowed to take place in order that the apparatus may give out a little light. The ideas of most people as to the action of a vacuum as well as an air space are considerably modified after a trial of this apparatus.

The efficiency of all heating apparatus depends considerably on *the rate* at which energy is set free, because the less the time in which the evaporation can take place the higher the efficiency. A very high efficiency in an apparatus means that very large currents must be used, which necessitate special wiring, and it also results in frequent destruction, through overheating, of containing vessels or resistances.

**Miller & Woods,**
*per* L. M.

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**Relative Safety or Danger of Electric Light Current.**

This subject opens such a wide field for scientific research and discussion, that I fear it would take up too much valuable space in your journal to go fully into the pros and cons relating to it; therefore, briefly, I may say I am not in favour of adopting the present alternating current circuits, (with the ever changing periodicity) for delicate surgical operations, however convenient they may be, for the simple reason that such currents as now supplied are not either safe or reliable, though probably in the near future Mr. Tesla may show us how to safely utilise them to advantage for medical work, &c., &c. Another great objection is that the medical practitioner would require such a host of expensive instruments to satisfactorily utilise and apply the alternating current, that the average medical practitioner would hesitate a great deal before going to a large necessary expenditure for the sake of the trifle to be gained in first cost for the small amount of current consumed and required for electro-medical and electro-surgical operations. Probably as soon as some reliable method is invented to enable hospitals and medical men to charge, say 30 to 40 small storage batteries from the main alternating current circuit, then such currents may be conveniently and safely applied, but until some economical and reliable method of this kind is forthcoming I do not think that Dr. Waite has much to fear that the well understood "voltaic or galvanic appliances" will be quite snuffed out in order to give way to the modern ways of obtaining current, however convenient it may be for the doctor to be enabled to tap it at any moment. However, according to the present state of the modern art, this fallacious convenience melts away when one considers the unreliability of fuses, cut-outs, resistances, and some types of current controllers and other expensive instruments required in order to properly utilise either the direct or alternating main circuits to advantage, and I doubt very much if there exists to-day any medical practitioner, or even your correspondents Lawrence and Kirk, or even "In Statu Pupillari," who could, or would care to apply same for carrying out gynecological, neurological, delicate electrolytical and many other advanced surgical operations with current varying as they do, say from about 250 milli-ampères for the former, whereas a current rarely ever exceeds 25 milli-ampères for the latter work, hence the difficulty of utilising the alternating currents for carrying out successfully the objects in view, setting aside the elements of danger which exist in more ways than one in the present state of the art.

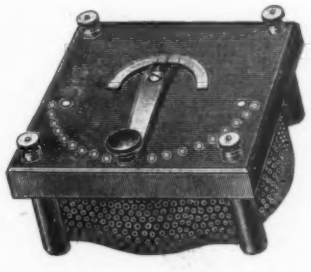
A 2,000-volt transformed main circuit current is bad enough for medical electricians to cope with, but when it comes to sitting behind a 20,000-volt pressure, reduced it is true to 100 volts in the surgery, simply trusting to the bare protection perhaps of a corroded fuse, or to the faulty insulation of a badly constructed transformer, fixed, perhaps, in a damp situation in the vicinity of a faulty gas or water pipe; in such a case I must confess I should not care to be the patient to be operated upon, even were I in the hands of the most skilful scientist of the day, and I quite agree with Dr. Waite who is a well-known "American authority" on matters of this kind, that the subject is one which should be fully considered by expert electricians before such methods are largely introduced. It is true we have not heard of any serious calamity taking place in the surgery so far, for the simple reason there is not one medical man in a thousand using up-to-date main circuit currents, but as the modern practice increases, which undoubtedly it will, unless the most stringent rules are adhered to and the greatest precautions carried out, I should not be surprised at any moment to hear of some serious disaster occurring from the utilisation of the alternating currents for medical work, and I think Dr. Waite has done good service in publicly bringing this subject before the electrical fraternity to consider and discuss what should be done on all points bearing upon the above subject.

It is all the more necessary at this juncture because the advantages of the electro-surgical and electro-therapeutical science is being greatly extended amongst a certain school of medical men, many of whom are undoubtedly waking up to the advantages to be gained by the application of electricity as a cure for certain diseases, which in many cases is far superior to that of medicine.

My advice to medical men and hospital authorities is by all means instal electricity for lighting purposes, which current can also be safely and economically used to ventilate the buildings, pump the water, lifting the patients from floor to floor, and with proper precautions can be made applicable for working electro-motors for driving the dental and surgical drills, bone cutters, and in some cases for galvano-cautery work as well, but for all round general requirements of the average electro-surgeon both as regards economy and convenience, and above all absolute safety, there is nothing to my mind to beat the modern chemical enclosed cabinet battery fitted with 40 to 60 cells, as now supplied by the leading firms catering for this branch of the industry; the battery cabinets, moreover, form a handsome piece of furniture for the surgery and if fitted with say a "Law standard cell," which is about the best and most useful battery for electro-surgical work, owing to its very great carbon surface, the resistance of the cell is reduced to a mimium, hence its suitability to carry out delicate operations requiring currents from say zero to 1 and from 2 to 250 milli-ampères of current, according to the nature of the operations to be carried out. The great advantage of these modern chemical appliances is undoubted when one comes to consider the cost of maintaining a Waite & Bartlet or "Law standard physician's cabinet battery," will not exceed 20s. to 25s. a year for chemicals and zincs used say for a 40 or 60 cell cabinet, provided the "Law cell" with its specially prepared zincs are used in each case to generate the current.

This chemical battery is applicable for carrying out the most delicate Faradaic, galvanic and also modern cautery operations when used in conjunction with the many well-known standard electro-surgical and electro-medical appliances, as sold by electrical firms, and I am bound to say from an electrical point of view, that they will fill all requirements needed by the average physician.

Now, as to alternating current appliances I may say my firm recently manufactured for Messrs. Mackey, Mackey & Co., the well-known dealers in surgical appliances, a complete electro-surgical plant for utilising alternating currents, and like Messrs. Lawrence and Kirk, I saw the difficulty and one of



the dangers to be overcome in harnessing the A. C. current, so I designed a specially constructed current controller with multiple fuses and cut-outs of different capacity, calculated to a nicety in order to break the circuit at two stated pressures, designed as per sketch enclosed herewith, the construction of which will explain itself. This appliance, I may say, took up a great deal of time, thought, and many experiments to get perfect in order to meet and fulfil all general requirements; from a safety point of view it now works perfectly, and in the

future may probably fill a want in some cases where the medical practitioner insists upon utilising the alternating current as supplied from central stations, when this appliance I venture to say may be found very useful in many electro-surgical operations, but so far, from a trade point of view, there is no demand at present for such an appliance, hence I came to the conclusion that it would be better to lock it up until the demand came. Whether this will ever come into operation or not in the face of the known merits and safety of chemically generated currents, is a matter upon which I will not predict or make any further comments, but will for the present content myself to watch and wait for results, however, should any demand arise for same.

**Arthur Shippey.**

*May 24th*, 1893.

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**Figure of Merit of Mirror Galvanometers.**

Could you let me know, through the medium of your paper, the smallest electromotive force that a Sir W. Thomson's mirror galvanometer will measure?

**J. B. Brantingham.**

[A Thomson's mirror galvanometer, wound to 6,000 ohms resistance will, if adjusted sensitively, give a deflection of one division with an electromotive force at its terminals of one millionth of a volt.—EDS. ELEC. REV.].

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**Electrolytic Chlorine and Soda.**

I have been waiting for the conclusion of Mr. Andreoli's remarks on the above subject before commenting upon or replying to a part of them. He is delaying it for some reason or another, but delays are sometimes dangerous.

I gather from this gentleman's criticism of the work done at Snodland by the Electrolytic Caustic Soda and Chlorine Trust, Limited, in the way of the practical electrolytic production of caustic soda and bleach, that he is displeased with some things done there, including the potential employed for each electrolytic tank. But if, instead of running foul of the reports of eminent experts, he had only placed himself in communication with myself, or the other gentlemen he has thought it necessary to refer to, he would have learned that this potential (6 volts) was given purposely as a maximum for all time for doing practical work of this description, and that its reduction was by no means difficult, but anticipated in the reports to which he has referred. [At the time of the reports, the anodes had been at work some months, night and day, and being eaten away they were thus shorter and the resistance higher, but it was purposely arranged not to lower or interfere with them, so that data might be acquired.]

It will be appreciated by practical men, if not by Mr. Andreoli, that it was better to establish a maximum practical working voltage and bring that down, rather than to base any calculations upon theoretical ideas, or upon the spasmodic working of a comparatively toy plant, as has been, and is still, I believe, being done elsewhere without any useful result. I say toy plant, because I believe that, excepting the works at Snodland, there is no such practical experimental works for turning out solid caustic soda and bleaching powder (samples of which I herewith send you) electrolytically; and it is simply conceit on Mr. Andreoli's part to attempt, or to suppose himself able, to criticise the practical work there carried on.

I am very glad to be able to state that hardly a week passes but that something is done at Snodland in the way of commercial improvement of the apparatus or method of working. The potential is being steadily reduced (already from 6 to 5 volts, including length of mains) without in the slightest degree diminishing the density of current, or adding to the cost of the apparatus or its working, and before long it is hoped to bring the potential down to below 3 volts, by a judicious use of a depolariser; but it will be done practically, and not merely on paper or in the head.

If Mr. Andreoli, or anyone else, will say where an electrolytic apparatus can be inspected which has turned out a single ton of 70 per cent. soda per week, in this country or any other, we will go to see it.

The fact is, there is no such plant in existence, or that ever has existed, except at Snodland, and Mr. Andreoli, being an unsuccessful rival in the direction of electrolytic bleach liquor, is blinded to the significance of this fact.

**James C. Richardson.**

Snodland, *May 24th*, 1893.

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**Armature Heating.**

In your issue of to-day's date, I notice you give an account of a test of a "Holmes" dynamo, taken at Thames Ditton. In the text the actual rise (the difference of thermometer readings) is stated to be 24·8° Cent., or 44·7° Fah., which latter is corrected by editorial note to 76·6° Fah.

The initial and final temperatures expressed in degrees Fah. are clearly

$$\left(29{\cdot}5^\circ \text{ Cent.} \times \frac{9}{5} + 32\right) \text{ and } \left(57^\circ \text{ Cent.} \times \frac{9}{5} + 32\right)$$

The difference between final and initial temperatures

$$\left(\text{less rise in room } \left(2{\cdot}7^\circ \text{ C.} \times \frac{9}{5}\right)\right) = \left(57^\circ \text{C.} \times \frac{9}{5} + 32\right)$$

$$- \left(29{\cdot}5^\circ \text{ C.} \times \frac{9}{5} + 32\right) - \left(2{\cdot}7^\circ \text{ C.} \times \frac{9}{5}\right).$$

This you will at once see gives an actual rise of 44·7° Fah., thus proving that in the editorial correction, the difference between two temperatures has been confounded with actual temperature.

**J. H. Garratt, A.I.E.E.**

*May 26th*, 1893.

[We are much obliged to our correspondent. The error was discovered, however, just too late to delete the foot note, and Mr. Andersen was at once notified by letter that the mistake had arisen from the very cause suggested by Mr. Garratt. We should not wonder if further exception will be taken to the temperature account of that machine on another point. As a matter of fact the figures are all correct; but the manner in which Messrs. Holmes subtract something from something else to make up what they call the rise of temperature, does not coincide with our own view, which is simply to subtract temperature of room at the end of the run (in this case 26° C.), from temperature of armature (57° C.), and state the difference (31° C. or 55·8° F.), as the rise of temperature, which alone is of interest to the user.—EDS. ELEC. REV.]

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**Train Lighting.**

From Mr. Evelyn-Liardet's letter in your last issue, I see the point complained of is that we appropriated that gentleman's plan patented on December 10th, 1881, "for utilising the motive power of the axles of railway trains for driving dynamos (preferably that of the guard's van) to charge accumulators, and from them to light the whole train." I would, however, point out that Mr. Radcliffe Ward, of electric omnibus fame, secured a patent for the same purpose on June 10th, 1881, No. 2,538, and that Prof. Tommasi did likewise on September 20th, 1881, patent No. 4,057, both of which you will see are before Mr. Evelyn-Liardet's. I think a reference to the Patent Office records would prove that the idea of running a machine from an axle of a railway carriage was very much patented before 1881; but so far as I can learn, the combination of driving a dynamo from an axle, and using accumulators for train lighting, was patented first by Mr. Radcliffe Ward, who permitted his patent to lapse.

If Mr. Evelyn-Liardet thinks that the late Mr. Stroudley and I claimed priority in using a railway carriage axle for running a dynamo, he is in error. What we simply did was, with the help of our assistants, to make improvements sufficient to enable the plant to safely run at varying speeds, join up and disconnect the circuits automatically, and maintain a constant light without the aid of a travelling attendant. We were, perhaps, the first to do this in England with block trains, and, as I read it, Mr. Langdon was kind enough to give us the credit for so doing, just as in the same way it is well known that to that gentleman is due the honour of being the first to successfully run trains in which each vehicle carried an independent light. I enclose a copy of the Stroudley and Houghton patent, No. 2,579, of 1883.

**E. J. Houghton.**